THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE IV. VOL. I.

No. IV.—APRIL, 1894.

ORIGINAL ARTICLES.

I.—On the Structure and Affinities of the Genus *Solenopora*, together with Descriptions of New Species.

By Alex. Brown, M.B., M.A., B.Sc.;
Assistant in the Natural History Department in the University of Aberdeen.

(PLATE V.)

In the present paper I propose to give the results of a series of investigations carried on in the Zoological Laboratory of the University of Aberdeen. Through the kindness of Professor Nicholson, I have had access to his admirable collection of specimens of *Solenopora*, Dyb., and I have also had the privilege of using his extensive series of microscopic preparations of the same. With such material, and with additional preparations, I have been enabled to examine, not only species already described, but also a number of new species, of which I shall in this paper give brief descriptions. From examination of all these forms, I find it now practicable to determine the true nature of the genus *Solenopora*, Dyb.

This genus has been described from time to time under various names; but there is no doubt that *Stromatopora compacta* of Billings, *Tetradium Peachii* of Nicholson and Etheridge, *Solenopora spongioides* of Dybowski, and *Tetradium Peachii*, var. *Canadense* of Foord, are in reality names of the same organism. This particular form, described under these various names, is known as occurring in the Ordovician rocks of Canada, Esthonia, Scotland, Wales, and Shropshire; and will doubtless ultimately be detected in other regions in strata of corresponding age. A full description of the species, under the title of *Solenopora compacta*, Billings sp., was given in 1885 by Prof. Nicholson and Mr. R. Etheridge, jun. (Geol. Mag. Dec. III. Vol. II. p. 529). At a later date Prof. Nicholson further described another species, *Solenopora filiformis*, from the Craighead Limestones (Geol. Mag. Dec. III. Vol. V. p. 15, 1888). Still more recently specimens were obtained from the Great Oolite of Gloucestershire and Yorkshire, which, though differing in structural detail, can be readily recognized as another species of the genus *Solenopora*. Thus, the geological range of this organism can be now extended from the Ordovician series to the Jurassic rocks. Additional specimens have also been examined from Esthonia, and from Craighead, Girvan; these showing important structural peculiarities, and reminding one at once of the well-known Nullipores and other calcareous Algæ of the present day.

In a monograph on *Solenopora compacta* (Geol. Mag. Dec. III. Vol. II. p. 529), Professor Nicholson refers the genus *Solenopora* temporarily to the Hydrozoa; but he says that "if evidence can be obtained, proving decisively the existence of a *cellular*, and not a *tubular*, structure in *Solenopora*, then the reference of the genus to the calcareous Algæ will follow as a matter of course." Now, from recent investigations carried on upon all the forms enumerated, and from a comparison of structure of these with those of Tertiary and recent Corallineæ, I have been led to the decisive conclusion that the genus *Solenopora* is in reality an ancient form of the same great group, to which our existing *Corallina*, *Amphiroa*, *Melobesia*, and *Lithothamnion* belong. Before discussing this subject in detail, however, it will be advisable that I should give a brief description of the various species of *Solenopora* with which I am at present acquainted.

I. Description of Species.

1. *Solenopora compacta*, Billings sp.

Stromatopora compacta, Billings. "Palæozoic Fossils" (1861–65).
Tetradium Peachii, Nicholson and Etheridge, jun. Ann. and Mag. Nat. Hist. ser. iv. vol. xx. p. 166 (1877).
Solenopora spongioides, Dybowski. "Die Chaetetiden der Osbalt. Silur. Form." p. 124, taf. ii. figs. 11*a*, *b* (1877).
Tetradium Peachii, var. *Canadense*, Foord. Contrib. Micro. Pal. Sil. Rocks, Canada, Geol. Survey, 1883, p. 24.
Solenopora compacta, Nicholson and R. Etheridge, jun. Geol. Mag. Dec. III. Vol. II. No. 12, p. 529. Dec. 1885.
Solenopora compacta, Nicholson. Geol. Mag. Dec. III. Vol. V. No. 1, p. 15, Jan. 1888.

"This species occurs in subspheroidal masses, from the size of a hemp-seed up to the dimensions of an orange. External surface lobulate. Fractured surface has a porcellanous, sometimes fibrous aspect, and is usually white or light-brown in colour. The fractured surface also shows signs of a more or less obvious composition out of concentrically-disposed strata" (Nicholson).

In vertical section the cells are elongated, arranged in a radiating and parallel fashion, and are often disposed in concentric layers. Diameter of cells about $\frac{1}{17}$ mm. The cells have distinctly undulating walls (Fig. 1).

In tangential section the cell-walls appear sinuous, and in many cases traces of active cell-division are observed. Certain specimens show a distinct variation in the size and form of the cells. In these two sets of cells are to be noted—one set small, with a wavy or polygonal outline; the other set large, elongated or oval in form, and scattered irregularly amongst the smaller cells. The large cells represent the spore-producing cells (sporangia), and the small the ordinary tissue-cells of the organism (Fig. 2).

Varieties.—There exist certain varieties of the above species which differ from the type-form, either in the size of the tissue-cells, or in the structure and form of the cell-walls.

Solenopora compacta, var. *Trentonensis*, nov. var. This variety, illustrated in Fig. 2, is found in the Trenton Limestones, and varies

somewhat from the type. The tissue-cells have their walls somewhat polygonal, and only feebly sinuous. Cell-division, too, is not observed to be in the same state of activity as exhibited in the ordinary forms.

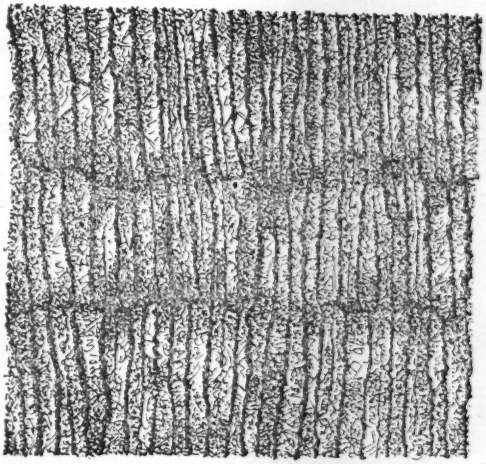


fig 1

FIG. 1.—Long. sect. *Solenopora compacta*, Bill. sp., × 50 d., showing concentric arrangement of cells.

Solenopora compacta, var. *Peachii*, Nich. and Etheridge, jun. Prof. Nicholson has noted that certain specimens obtained from

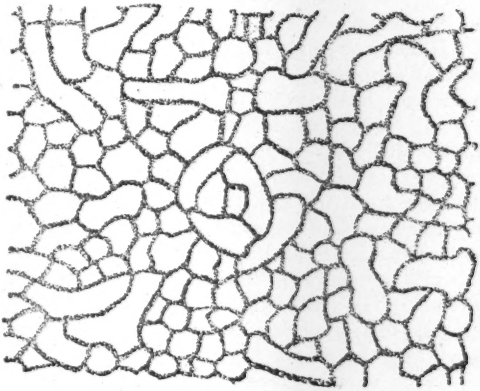


fig 2

FIG. 2.—Tang. sect. *Solenopora compacta*, Bill. sp., from the Trenton Limestones, × 100 d. Larger cells seen in section are the spore-producing cells (sporangia).

the Craighead Limestones, Girvan, Ayrshire, possess much wider cells than any other form examined. They are alike, in every

other particular, to the typical species described from Canada and Esthonia, and so he distinguishes the Ayrshire forms as a special variety—*Solenopora compacta*, var. *Peachii*.

Observations.—It is observed that throughout the whole of the above species increase takes place for the most part by longitudinal division of the tissue-cells, and that the cells tend to grow in length more than in breath. Not only so, but there seems to exist a species of sub-dichotomy or sub-trichotomy by which two or three peripheral cells arise from the outer end of a more central cell (see Fig. 1). This process has also been found to occur in certain of the calcareous Algae[1] (e.g. *Lithothamnion*). Transverse division occurs in other species, and in the description of the following forms it will be seen that there are types, very like *Solenopora compacta*, in which cell-multiplication by transverse fission is the rule. Even in the present species such a mode of increase is by no means entirely absent.

Formation and Locality. — Ordovician, Craighead Limestones, Girvan, Ayrshire; Trenton and Black River Limestones, North America; Limestones of Saak, Esthonia, where it makes up great beds of limestone, most of the examples in this case being comparatively small. Dr. Dybowski also obtained it from Herrküll, Esthonia, in beds of Ordovician age ("Borckholm beds" of Friedrich Schmidt). The specimens examined are from the collection of Prof. Nicholson.

2. *Solenopora lithothamnioides*, n.sp. (Pl. V. Fig. 2.)

The single specimen examined shows that this species occurs in conical masses of the size of a walnut. Its fractured surface has a distinct porcellanous aspect, and exhibits a greyish-brown colour. It possesses the concentrically laminated structure characteristic of the genus. It is much harder and more compact in texture than any of the other species.

In vertical section distinct concentrically arranged layers of cells are seen. Each layer is composed of numerous cells arranged in parallel rows. The walls of the cells are slightly sinuous, when examined with a high power. The transverse divisions between the cells are thinner than the vertical divisions, and in many cases are obliterated, leaving fine concentrically disposed clear markings. Cells $\frac{1}{14}$—$\frac{1}{28}$ mm. long and $\frac{1}{10}$—$\frac{1}{20}$ mm. broad. In tangential section the cells are more or less rounded and only slightly sinuous in their outline. The cell-walls are thinner than in *S. compacta*.

Observations.—This species is nearly allied to *S. compacta*, and differs mainly in the character and form of its cell-wall, in the greater regularity of the concentric layers, and in the fact that each concentric layer is composed of parallel rows of small cells. As regards the last point, the same may be true of *S. compacta*, if we are to accept the presence of the commonly observable fine concentric clear spaces as indicative of the original divisions between

[1] A. Rothpletz, "Fossile kalkalgen aus Familien der Codiaceen und der Corallineen." Zeitschr. d. Deutschen geolog. Gesellschaft, Jahrg. 1891.

the cells. These spaces are well displayed in specimens from the Trenton limestones and from Esthonia, which specimens are assuredly examples of *Solenopora compacta*.[1] In the specimens of *S. compacta* hitherto described no definite proof has been found that these spaces do correspond to cell-walls. In *Solenopora lithothamnioides*, however, distinct walls are seen which agree in position with the clear markings seen also in the same species (see Pl. V. Fig. 2).

Formation and Locality.—Ordovician (Silurian?), Shalloch Mill, near Girvan, Ayrshire. (Coll. H. A. Nicholson.)

3. *Solenopora nigra*, n.sp. (Pl. V. Fig. 3.)

This species presents itself in small oval, ovate, or rounded masses up to the size of a pea. It has always a dark appearance, and it is very difficult to prepare good transparent sections from it. When fractured the concentric arrangement in layers is well seen, and the surface presents a porcellanous or somewhat fibrous aspect. In vertical section the distinct concentric layers of cells peculiar to the last species are not nearly so manifest. The cell-walls are thick, dense, and feebly sinuous, the transverse equalling the longitudinal in thickness. Cells $\frac{1}{30}$—$\frac{1}{60}$ mm. wide and about $\frac{1}{6}$—$\frac{1}{17}$ mm. long. The cells near the point from which radiation proceeds are much narrower and longer than the peripheral cells. The whole cellular tissue often tends to assume a fan-like appearance. In tangential section the cells appear rounded or oval, and somewhat sinuous in their outline. Walls thick, and cell-division active (Fig. 3).

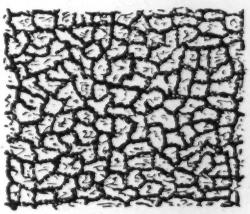


fig 3

Fig. 3.—Tang. sect. *Solenopora nigra*, n sp., from Esthonia. × 50 d.

Observations.—This species occurs in great masses of limestone, of which it is one of the principal constituents, and such is the appearance of a mass of this limestone that one might readily mistake it for an ordinary Nullipore limestone such as we meet with in the Tertiary series. One is struck, also, with the similarity in form, appearance, and arrangement of the cells, to what is

[1] These concentrically arranged clear spaces were alluded to by Prof. Nicholson in the Geol. Mag. Dec. III. Vol. II. No. 12, p. 533, December, 1885. He showed there also that, corresponding to the clear spaces in the tubes, there were interruptions in the longitudinal walls.

found in the species to be next described, viz. *Solenopora Jurassica*, Nicholson.

Formation and Locality.—Ordovician Limestones, Saak, Esthonia, Russia. (Coll. H. A. Nicholson.) Here it occurs along with *S. compacta* and *S. dendriformis*.

4. *Solenopora Jurassica*, Nicholson (MS.).

This form occurs in subspherical masses varying from the size of a marble to that of an orange or even larger. The fractured surface has a porcellanous appearance, and shows the arrangement in concentric layers very markedly. Each layer has a reddish-brown colour internally, fading into a whitish appearance externally.

In vertical section the cells are arranged in a radiating fashion. They have about the same diameter as those of *Solenopora compacta* (about $\frac{1}{17}$ mm.), and their length varies from $\frac{1}{7}$ mm. to $\frac{1}{3}$ mm. The arrangement of the cells is upon the same principle as in *Solenopora nigra*, and they do not group themselves into layers corresponding to the concentric strata seen with the naked eye. The cell-walls are very distinct, and not sinuous. The transverse walls are slightly concave on the peripheral side (Fig. 4). Certain zones are observed

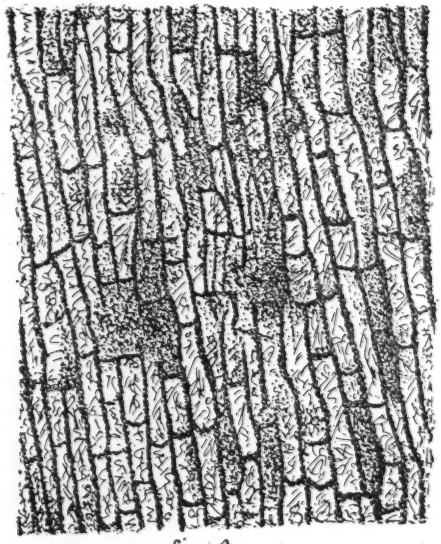


FIG. 4.—Long. sect. of *Solenopora Jurassica*, Nich. (MS.), from Chedworth, Gloucestershire. × 50 d.

to have their walls either very indistinct or obliterated by crystallization. These zones correspond to the more lightly coloured portions of the concentric layers of the mass as visible to the unaided eye. Some sections show oval or rounded spaces here and

there, which are, in all probability, the remains of the reproductive organs (conceptacles). In tangential section the cells appear more or less rounded, and also often polygonal. Cell-division is active, and where the cells are not polygonal intercellular spaces are observed to be present. In certain sections are found spaces of a rounded or oval character; and, further, in the same specimens, are observed at intervals clusters of cells arranged in a rosette-like fashion (see Fig. 5). This latter condition may simply be due to the results of cell-division; but to this I shall refer later on. The empty spaces may be all that is left of former reproductive organs.

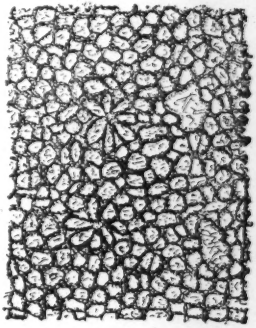


fig 5

Fig. 5.—Tang. sect. of *Solenopora Jurassica*, Nich. (MS.), from Malton, Yorkshire, showing rosette-cells and spaces (conceptacles). × nearly 50 d.

In one specimen from Malton these spaces are arranged in a row, but there was great difficulty experienced in getting good sections for examination, on account of the imperfect state of preservation.

Observations.—This is the only species of Jurassic age yet known. It occurs under the same conditions as the other species. The form of its cells has already been shown to be similar to those of *Solenopora nigra*. The distinct nature of cell-walls, both transverse and longitudinal, places it apart from all the other species.

Formation and Locality. — Jurassic, Great Oolite, Chedworth, Gloucestershire, and Malton, Yorkshire. (Coll. H. A. Nicholson.)

EXPLANATION OF PLATE V.

Fig. 1.—Vertical section of a Tertiary Nullipore (*Lithothamnion*), from "Leitha-Kalk" of Austria. × 25 d.

,, 2.—Vertical section of *Solenopora lithothamnioides*, n.sp., from Shalloch Mill, Girvan, Ayrshire. The specimen shows concentric layers of cells, each layer being composed of numerous cells arranged in parallel rows. × 12 d.

,, 3.—Vertical section of *Solenopora nigra*, n.sp., from the Ordovician Limestone of Saak, Esthonia. × 25 d.

,, 4.—Vertical section of *Solenopora fusiformis*, n.sp., from Craighead, Girvan. A great part of the specimen is destroyed, and the structure obliterated by secondary crystallization. × 12 d.

(*To be continued in our next Number.*)

II.—On the Sand-grains in Micaceous Gneiss from the St. Gothard Tunnel; and on some other Difficulties raised by Prof. Bonney.

By Dr. F. M. Stapff.

FROM the "Annals of British Geology," 1892, No. 533, p. 294, I find that Prof. T. Bonney doubts the occurrence of sand-grains in the Guspis micaceous gneiss,[1] as stated by me in various reports on the geology of the St. Gothard Tunnel, and repeated on p. 17 of my "Remarks on Prof. Bonney's paper on the Crystalline Schists and their relation to the Mesozoic rocks in the Lepontine Alps."[2] The question being of some general interest, and not only of importance for the comprehension and classification of the crystalline schists in the Lepontine Alps, I think it desirable to repeat here the *observed facts*, and to present to the notice of the readers of the Geological Magazine some *autotype prints* of the rock in question. I am the only geologist who has seen these beds in situ, when they were opened by the St. Gothard Tunnel; and it would be rather difficult for anyone to make out their outcrops along the line of profile through the Guspis Valley and below the actual moraine of the St. Anna glacier, without taking into consideration the faults and thrusts in this tract, which are indicated on my geological map of the St. Gothard Railway and on the profile of the tunnel.

I beg leave to quote a passage from the geological records kept during the construction of the St. Gothard Tunnel (Geologische Durchschnitte und Tabellen über den grossen Gotthard-tunnel; Spezialbeilage zu den Berichten des Schweizerischen Bundesrathes ueber den Gang der Gotthardbahnunternehmung, 1874–1882; Zürich Orell Füssli), which refers to the bed No. 130; 7262, 4 m. from the northern entry (*loc. cit.* p. 178–9) :—

"No. 130; 1879, Sept. 4th; *ditto* (fine-grained rather dense gneiss) *with sandy quartz-grains*; 7262, 4 to 7278, 3 m.; false-stratification 20 W. and 77 E. to 5 E. and 64 W., average 11 W. and 82 W. Samples taken at 7262, 4. Fine-grained, rather dense, micaceous gneiss, rough, almost tufaceous (but not porous), of reddish-grey colour and confused parallel structure, which is indicated by shreds of brown mica. In this groundmass grains of *quartz* and *felspar* of the size of a peppercorn and smaller are disseminated, whence the rock assumes a porphyritic structure. Some crystalline outlines of dull, whitish, faintly glittering *felspar* may plainly be recognized. The grains of *glassy* and milky quartz show an iridescent, glossy, conchoidal fracture; they are *rounded*, with some crystal facets here and there; enveloped by thin mica-films (macroscopically visible), which can readily be loosened and picked out from the groundmass. The presence of *calcspar* is indicated by effervescence, especially around the quartz-grains; other *accessory minerals* are: *pyrites* and rarely minute fragments of *tourmaline*.

[1] See Correspondence, Geol. Mag. 1892, p. 90.

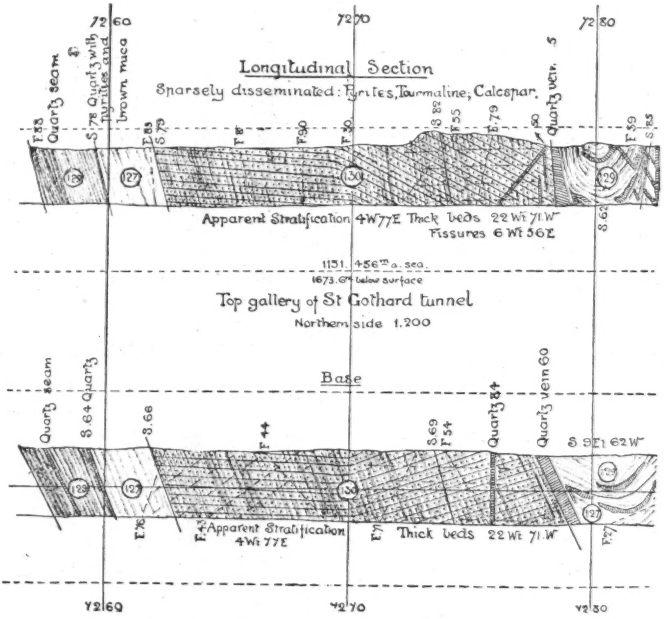
[2] Geological Magazine, January, 1892, Dec. III. Vol. IX. pp. 6–21.

Microscopic observations.—The contours of the larger quartz-grains (as far as they have not been broken out by the grinding operations) are rough but not splintery; the grains are partially wrapped in some longer pellicles or shorter split scales of brown mica. Other grains are surrounded by a garland of fine mica films, which occasionally seem to extend into the quartz-grains. *Calcspar*, together with occasional quartz splinters, is deposited in these mica envelopes, and is attached to the sandy quartz-grains without visible traces of abrasion. Each sandy quartz-grain forms *a single individual*, which is almost always fractured, with or without slight dislocation and torsion of the fragments. The cracks are often covered by a brownish-green substance. In the interior of the quartz-grains may be observed some *microscopic inclusions* of *opaque dust*, specks of *pyrites*, some of *mica*, a few small *lacunæ* (pores), and some short thin *colourless needles*. Here and there a fern-like figure is dimly seen, perhaps indicating the face of a microscopic crack, rather than any microlithic material. Most of the *plagioclastic felspar* is twinned, and the fine twin-striations are visible (in polarized light) though the felspar is in a state of advanced decomposition and intermixed with clusters of *mica scales*, which veil the striations. Though the outlines of the felspars are not so distinct as those of the quartz-grains, they are yet better defined and more clearly individualized than those of the ordinary crushed felspars in the micaceous gneiss; and thus they convey the impression of being porphyritic inclusions rather than indigenous constituents of the micaceous gneiss. The groundmass surrounding the grains of quartz and plagioclase is a compressed mixture of *quartz*, *felspar* and *two kinds of mica*, the films of which induce an indistinct parallel structure. A little *calcspar* also makes its appearance, partly in isolated granules, partly in larger groups of polysynthetic twins, which are cross-barred with the other minerals, so that it sometimes appears to be a constituent mineral, and sometimes a later-formed accessory cement. Microscopic accessories are *pyrites* (also *pyrrhotine*) in irregular masses, grains, and small crystal groups; and minute, but easily recognized, fragments of *tourmaline*. (So far microscopy.)

This rock appears to be one of the most curious from the interior of the St. Gothard massif. If it really be psammitic, as one may suppose from the foregoing, then all the stratified beds bored through in this massif must also be of sedimentary origin. It recalls to mind the *sericite slates* of the Ursern Valley, with their *glossy sand-grains*; a similar, though less characteristic, rock occurs at 5560–5600 m. from the southern entry. On newly-opened wall-surfaces in the gallery, the quartz-grains appeared to be arranged like *pearls in strings* (scarcely visible in hand-specimens); the strings did not agree with the *parallel structure* of the rock, but rather with its false-bedding (or secondary schistosity); and hence the interpretation of this feature, and of the rock itself, becomes still more complicated. At its margins the bed No. 130 is penetrated by compact veins of quartz and felspar, and further on it passes over into the ordinary micaceous gneiss. . . . ."

To this almost verbal translation I add Fig. 1, a copy from my *original survey sheets* (deposited in the archives of the St. Gothard R. R., Lucerne), after which the plate xxx. (northern side) of the "Geologische Durchschnitte" has been arranged and lithographed. It shows a longitudinal section and a base view of the bed No. 130, as exposed in the top gallery of the tunnel between 7260 and

FIG. 1.



7280 m. N. (Particulars, which are not relevant to the present question, are omitted.) The *parallel structure* of the rock (S. on drawing), as indicated by the orientation of the mica scales, the course of the parallel quartz-bands, and the boundary faces of the bed, strikes and dips N.E. and S.E., as is commonly the case on the north side of the St. Gothard; whilst the *supposed stratification* ("mock" or "false stratification") is directed N.N.W., dipping W. and E.; and the *quartz-grains are disposed in the same direction.* Having been accustomed to regard the "false stratification" wherever it was met with in the St. Gothard as "secondary," I cannot help confessing that the arrangement of the quartz-grains, in accordance with the "secondary stratification," would witness against the sedimentary origin of the bed in question. But this testimony is at once overborne and reversed if we conceive that this *stratification to all appearance* (beds between limiting faces) *is here the original one*, and that the parallel structure (S. of drawing) of the rock is a secondary phenomenon. Hand-specimens of the rock *support* this opinion, as the mica pellicles are fitted and *stretched* so as to indicate a *linear*

rather than a *plane* parallelism; but recently-exposed large faces of the rock allowed a more satisfactory decision to be arrived at.

As some 70 examples (belonging to as many St. Gothard Collections) of the rock in question are preserved in different Museums, it would not be difficult for anyone to examine its petrographical details. I give here (Fig. 2, natural size) an autotypic print of a

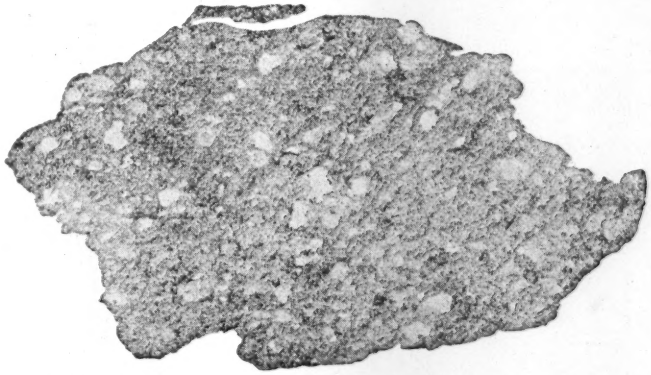


Fig. 2.—Natural size. Micaceous gneiss with sand-grains. Bed 130 (north) St. Gothard Tunnel.

polished face, which has recently been cut from a specimen in the direction of its most visible "parallel structure," as indicated by the mica; but some wavy undulating bands on the design indicate another orientation, which almost agrees with the trend of the imbedded quartz-grains. The quartz-grains (white spots on drawing) are, by their shape and lustre, easily recognized and distinguished from the felspar grains, and I cannot give a better description of their form, size, number and distribution, than can be seen in the figure.

The autotypic figures 3 and 4, which are taken by microphotography from my original thin slices (described in the "Geologische Durchschnitte und Tabellen" beforenamed) reproduce respectively *a grain of quartz* and *a grain of felspar* magnified 16–17 times. In order to show the *marginal lines* between the groundmass and the imbedded grains as clearly as possible, I have taken the photograph by polarized light; but by this method other particulars have been obscured or are not shown.

The quartz of the grains is apparently different from the constituent quartz of the enveloping micaceous gneiss. The former agrees with the quartz crystals occurring in *porphyries*, the latter with the quartz in *granites* and *gneisses*. Each quartz-grain of our rock forms a single crystallographic individual, which is frequently split, in one direction by a few clear parallel fissures, and in other directions by single irregular cracks. Sometimes the fragments of the fractured grain have not been at all dislocated, and then the polarization colour is homogeneous throughout the whole grain; in

some other cases there has been an insignificant displacement, and this is the case with the quartz-grain here figured; but these quartz-grains *never* present such a brilliant, polymorphous and polychromatic variegated mosaic as the small particles of quartz which enter into the constitution of the micaceous gneiss. Their polarization colours are somewhat dull, and fade away concentrically from the interior outwards, just as in the case of quartz crystals in porphyries.

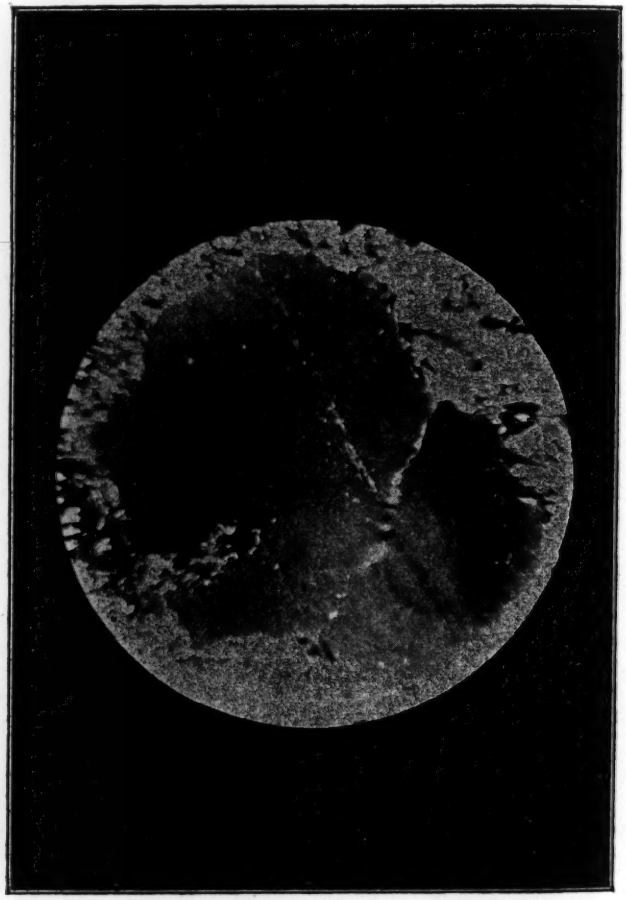


FIG. 3.—Quartz-grain in micaceous gneiss, No. 130 (north) St. Gothard Tunnel. Enlarged 16–17 times. Photographed in polarized light.

The *microlithic* (and other) *inclusions* in the quartz-grains are larger but neither so frequent nor so varied as those in the mag-

matic quartz-splinters. The thin, colourless, brilliant prismatic needles—not visible in figure—and the rhombic sections,[1] seemed to offer a special character since they were missing in the magmatic quartz-splinters; but later I found them also in the *holes* from which the quartz-grains had been broken out (abundantly), and finally outside the edge of the thin slice (rarely); whilst they were *wanting in another freshly-made microscopic section.* They seem *not to be connected with the material of the rock.* Some few microscopic scales of *brown mica* are deposited *on the cracks* in the quartz-grains; they appear to be later deposits and not inclusions in the crystallizing quartz. But some doubt may arise with regard to rare microscopic patches of brown mica and quartz, *i.e.* of the *enveloping material,* which appear to be inclusions, though they may quite as well be deposited above or below the grains, or they may be terminal points of lateral inclusions in bays of the quartz-grains (see figure). Small (microscopic) granules of *calcspar* likewise occur on *cracks* traversing the quartz-grains; and without doubt they have been deposited there *à posteriori,* just as well as the calcspar on the margin of the grains. The same cannot so decidedly be said about the granules of calcspar, which are interwoven in the texture of the micaceous gneiss; the less so, as they proved to be *dolomitic.*

The shape of the quartz-grains is always *roundish polygonal;* short, straight fragmentary edges of a crystal are interrupted or connected by curves and small fracture-lines; but the outline is by no means fringed by filaments or threads entering and losing themselves in the enveloping material. No regularity whatever can be recognized in the crystallographic orientation of the grains, either with respect to each other or towards the surrounding minerals; the different quartz-grains exhibit very different orientations and individual colours when the slice is moved between unaltered Nicols. And just as little can any *fluidal structure* be noticed around the grains. Short segments are wrapped up in extended pellicles of mica, which stick close to the outline of the grain and leave but little room for the deposition of other mineral particles; for the rest, small brown mica scales intermixed, to form a minute mosaic, with broken quartz (and some grains of felspar, calcspar, etc.) environ the foreign quartz-grains; and it is seen that the mica pellicles are twisted around the quartz-grains in such a way that longitudinal and cross sections alternate in one and the same profile. Hence the cavity from which a quartz-grain has broken out seems to be lined by a cuticle of brown mica; but, if that same cuticle is cut through, the sections vary very considerably at different places.

The demarcation line between a quartz-grain and its envelope is seldom quite clean and smooth. Microscopically seen it is, for the most part, rough, and small pellicles of mica and granules of quartz are attached to it (squeezed in, to all appearance); just as we see

[1] Mentioned in the translation from the Geol. Durchschnitte und Tabellen.

sand-grains and gravel encrusting the corrugated surface of a pebble. The cracks and fissures are sometimes enlarged at the surface of the bay, which allows the surrounding material to invade the grain.

The *felspar-grains*, of which one is reproduced on Fig. 4, are in part *polysynthetic twins*, in part *single* or *twofold* individuals. It is not easy to determine particular felspar species in view of the

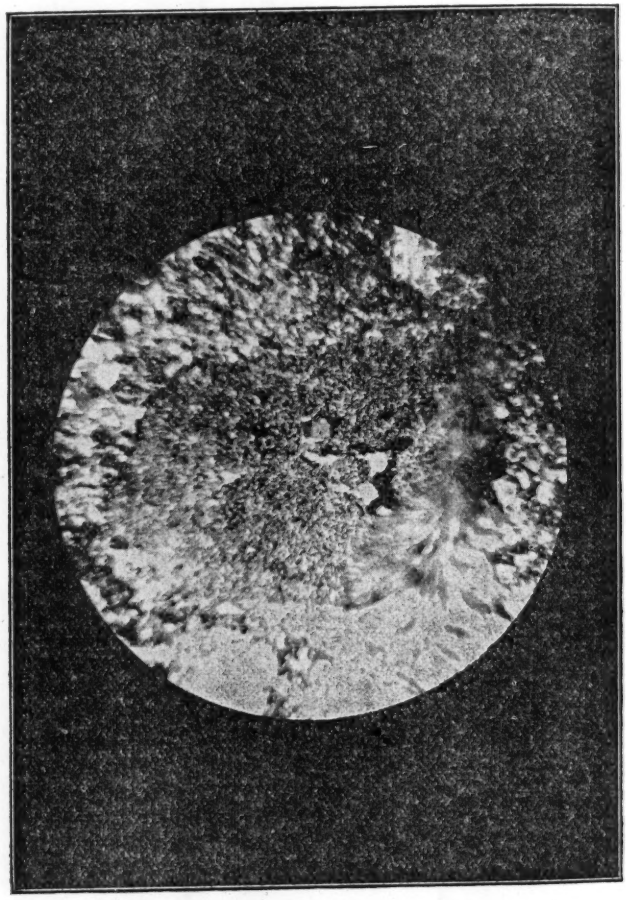


Fig. 4.—Felspar-grain in micaceous gneiss, No. 130 (north) St. Gothard Tunnel. Enlarged 16–17 times. Photographed in polarized light.

extent to which they are decomposed; but even with the naked eye one can observe that some of the felspar-grains are greenish, dull, lustreless, striped and dusty (*kaolin*); whilst others are white or limpid, fresh and glossy. Commonly they present the outlines of

crystals, but sometimes they are rounded; or they are split, broken and torn, as felspars in the squeezed St. Gothard gneisses so often are; and hereby we learn that the same felspar simultaneously makes its appearance as an ordinary constituent of the micaceous gneiss *and* as a porphyritic inclusion in the same.

The figured grain is porphyritic though rounded. It shows no twin stripes in polarized light, and its mass is almost replaced by clusters of pellicles of *potash mica* and *kaolin*. Small *quartz-grains* and other microliths accompany the mica in the decomposed felspar, which I need not further mention.

The outline of this grain of felspar—and of others similar—is not so well defined as that of the quartz-grains (Fig. 3), and to all appearance it has coalesced with the surrounding materials; a white margin indicating in some cases the zone of intermixture.

In spite of the roundish contours of many of the felspar-grains, I am *not* inclined to consider them to be grains of felspar *sand*. The occurrence of porphyritic segregated felspar in gneissic rocks is by no means unusual; and this may be the case in the quartzitic micaceous gneiss No. 130, where the lesser part of the felspar is intermixed with the other constituent minerals, and the greater is segregated.

The preceding observations put beyond every doubt that the *quartz-grains are foreign bodies:* their material is not identical with that of the constituent quartz of the micaceous gneiss, nor are there any transitions between the two kinds; each quartz-grain is an individual, loosely imbedded in the groundmass and easily picked out of it. Some of the apparent inclusions in the quartz-grains are *later depositions* on cracks, others are *squeezed in from the outside*, and with regard to the nature of others some doubt may be reasonably entertained. The question now is: have we to deal with *sand-grains* imbedded in an (originally) *sedimentary psammitic rock;* or with a kind of *quartz-porphyry*, the groundmass of which has been decomposed in such a way that it is now a micaceous gneiss? This second view is supported by the nature of the quartz-grains, and their association with porphyritic felspar-grains; whilst it is contradicted by the actual nature of the enveloping magma, by the lack of fluidal structure, by the arrangement of the grains in accordance with the bedding of the rock (Fig. 1)—*facts which corroborate the belief in the sedimentary origin of the bed.*

Prof. Bonney doubts also "*the occurrence of organisms in the Altkirche marble*"; but I question whether many share his opinion after seeing the autotype figures of the bodies in question, which are published in the Geological Magazine (1892, Dec. III. Vol. IX. p. 16),[1] with a footnote by the Editor (p. 17): "hand-specimens of these St. Gothard rocks are preserved in the Mineralogical Collection of the British Museum, and sections taken from the one marked No. 43 show precisely similar structures to those in the accompanying figure.—Edit. Geol. Mag."

[1] Reproduced by Professor J. F. Blake, in his Annals of Geology for 1892, p. 293.

"The reference of the Piora schists to the *Carboniferous* appears (to Prof. Bonney) to be only a hypothesis"—but, as a fact, I have not made such a reference. I have not dealt with his Piora schists, and would not say anything about them but (GEOLOGICAL MAGAZINE, *loc. cit.* p. 9) "that they belong to the second of my groups (that of the grey garnet schists) and his 'Val Tremola schists' to the third and fourth group (green, black felspathic mica schists, and amphibolic rocks)." What I have mentioned about the geological age of *these* (*my own*) groups is restricted to the following lines in the GEOLOGICAL MAGAZINE, p. 7: "If this parallelization be correct, and the metamorphosed sedimentary rocks of the Ursern Valley properly determined, then we may draw the conclusion that the series of the originally sedimentary rocks on the south side of the St. Gothard begins, at the bottom of the Ticino Valley, with *Jurassic* deposits and includes *Carboniferous* at about 1833 m.[1] inside the mountain, counted from the mouth of the tunnel." *Ibid.* p. 10: "The beds, in which disthene and kindred minerals can be recognized at a glance[2] . . . . . are usually connected with the calc-mica schists and black garnet schists, but it would be premature to assert that certain geological horizons in the grey mica schists are characterized by the appearance of disthene, etc." *Ibid.* p. 19: "5 The rocks belonging to the fifth series (on my geological map of the R.R. line), viz. dolomites, grey and green mica schists . . . . have been characterized in § I.–III., where it is pointed out that they extend from the *Carboniferous to the Jurassic* age."

I have nowhere advanced the hypothesis imputed to me by Prof. Bonney that his Piora schists (*my grey mica schists of the St. Gothard Tunnel*) *belong to the Carboniferous*; and, comparing the Geological Map of the railway line (Explanation on the title-page), the designation *Carbon* (?) will be found exclusively behind the references for: "Quarzglimmerschiefer mit Chloritglimmerschieferlagen, North, Pl. V."; "Schwarze phyllitische (chloritische) Schiefer mit Kalk—Quarzit—Gneiss-streifen (Oberalpstrasse)."

On the summary profile (title-page) the designation "*Carbon*" (?) is restricted to the black schists of the Oberalpstrasse, on the north side; to the black (and green) schists on the south side, *inwards from* 1100 or 1200 m. as mentioned above; and to the well-known *Manno grits.*

In the bathrologic review (on the same sheet of the map) the schists belonging to V., viz. "Granat-Amphibol-Paragonit-Chlorit-Sericit-Kalk-Glimmerschiefer," are designated as "Archacische[3]-Mesolithische Lückenbüsser."

[1] My "grey garnet schists" (*sint* Prof. Bonney's Piora schists) are reckoned from 90–1142 m.; my "black and green garnet mica schists" from 1142–1833 m. (GEOLOGICAL MAGAZINE, *loc. cit.* p. 9).

[2] *Sint* Prof. Bonney's "Piora schists."

[3] In the GEOLOGICAL MAGAZINE (*loc. cit.* p. 19) I have freely confessed that the reference to *Archæan* was a mistake of mine.

III.—The Mammoth Age was Contemporary with the Age of Great Glaciers.

By Sir Henry H. Howorth, K.C.I.E., M.P., F.R.S., F.G.S.

THERE has been a long and sustained discussion among geologists as to whether the Mammoth and its companions were pre-Glacial, inter-Glacial, or post-Glacial, or whether they could not, in fact, claim to have been both pre- and post-Glacial, and to have lived through the Glacial age, whence the name of *Dicyclotherium* proposed for the Mammoth by one writer.

These discussions have all, it seems to me, been vitiated by the postulate that the Drift, as we have it in Western Europe and North-Eastern America, was distributed by ice-sheets or icebergs. In my last published work I have devoted a large space to trying to prove that this view is a mistaken one, and that while we have ample evidence of there having at one time been much larger local glaciers, where glaciers still exist, and of there having been glaciers in many places where glaciers no longer exist, there is no satisfactory evidence of great ice-sheets having existed or being even possible and that it is impossible to assign the distribution of the Drift over a large area where it occurs, either to ice-sheets, or to ice in any form. On the other hand, I have argued that the Drift was very largely distributed by water; not by water acting by slow diurnal methods, but by water moving under the impulse of a great catastrophe. If this view be right it entirely alters the conditions of the problem about the true epoch of the Mammoth and its companions.

That the Drift, so far as our evidence goes, invariably overlies the Mammoth beds where the latter are *in situ* I have argued at great length in this Magazine, and have also adduced a great deal of evidence to prove it, and this evidence keeps growing. This means that the catastrophe which distributed the Drift was subsequent to the Mammoth age, and, in fact, I have argued that it was this very catastrophe which overwhelmed the Mammoth and its companions. I believe also that it was the final chapter in the history of the so-called Glacial period (which ought really to be styled the period of Great Glaciers), and that to it we must attribute almost entirely the last changes in the configuration of large parts of the Earth's surface of any importance.

This means that while the distribution of the Drift, as we find it, was rapid and sudden and was contemporary with the extinction of the Mammoth and its companions, the period of Great Glaciers which immediately preceded that diluvial movement was also the period during which the Mammoth and its companions flourished, and that the great beasts and the Great Glaciers flourished side by side—were, in fact, contemporaneous. This view, I submit, is in accordance with the facts and best explains them. To put the case more concretely, it is that while the Highlands of Scandinavia and Scotland, the Jura and the Vosges in Europe, and the mountains of British Columbia and the Laurentian Highlands in America, were nursing large glaciers, the Lowlands in the same latitudes were occupied

by forests and steppes, where abundant vegetable and animal life flourished, and that the era of Great Glaciers in Europe and North America corresponded to the current condition of things in New Zealand, where Great Glaciers exist alongside of thickets of luxuriant trees, amidst which the *Apteryx* and its companions thrive.

In order to illustrate this position we must divide the area over which the Mammoth and the Drift occur into three zones: (1) that in which Drift occurs, but not the Pleistocene beasts; (2) that in which the Pleistocene beasts occur, but not the Drift; and (3) that in which they occur together.

In regard to the first of these zones or provinces, it is remarkable that in Scandinavia, Finland and the Alpine country, and in the correspondingly glaciated districts of America, there should be a virtual absence of all traces of the Pleistocene fauna, not merely of the Mammoth and the Rhinoceros but of traces of such Arctic animals as the Musk Sheep, the Reindeer and the Ice Fox. These last creatures occur with the Mammoth and the Rhinoceros in France, Central Germany and Britain, but are not found in the Alps, in Scandinavia, or the Highlands of Scotland, although now flourishing in the highest latitudes. They seem to have abandoned those areas for others where food and other conditions made life supportable. Not only so, but we do not find that in the areas where the Pleistocene beasts occur that they are assorted according to climates, but they occur together at Zurich and on the borders of the Alps and in Scotland just as much as in Southern France. All this surely points to the sharp separation in locality, but not in time, of the Pleistocene fauna of the plains from the barren uplands. This distribution of the fauna of the Pleistocene age seems to me to afford strong evidence that the Great Glaciers of the high lands were contemporary with the existence of the Pleistocene fauna elsewhere.

If we turn from these districts to those where the Mammoth and its companions have occurred, but where there is no Drift, we shall be constrained to the same conclusion.

It is a remarkable fact that if we limit ourselves to the plains of Northern Siberia, excepting a fringe of land bordering on the Arctic Ocean which has recently risen from the sea and contains deposits of very recent marine shells, there is no evidence that a period of severe cold other than that now existing has marked the climate of Siberia since the Mammoth was extinguished. The existence of carcases in their flesh, and of very recent-looking Molluscs and tree trunks in the surface-beds of Siberia, all point to the age they represent having been the last one; and that the only glacial conditions which have existed in Siberia are those now current there, the climate having become more and more severe since the Mammoth age. This means, if evidence is to go for anything, that the Mammoth age in Siberia and North-Eastern Europe, which was its last epoch, was contemporary with the Great Glaciers elsewhere.

In regard to Siberia, Mr. James Geikie, the great champion of extreme glacial views, fully admits that there are no traces of glacial action there, and that the beds in which the Mammoth remains occur are the latest, and thus correspond to the Drift beds; and he, in fact, actually argues that "the Mammoth and the Woolly Rhinoceros may have survived in Northern Asia down to a comparatively recent date" (The Great Ice-Age, pp. 554–556, and notes). I cannot see how the conclusion can be avoided, in fact, that in Siberia the Mammoth age was strictly contemporary with the development of Great Glaciers in Europe and North-East America. Nor do I know anyone who would contest it.

What is true of Siberia is equally true of that outlier of Siberia—Alaska—which resembles it in every way, in the absence of traces of old glaciation in the preservation of great masses of remains of Pleistocene beasts in a very fresh condition, whose very freshness, as in Siberia, points to their having lived in the very latest geological period, and contemporaneously with the glaciation of the country round Hudson's Bay further east.

So much for Siberia and Alaska; but it is not possible to separate Siberia from European Russia. The continuity of conditions of the fauna and of the surface-beds is complete, as I have shown elsewhere. North-Eastern Europe is, from the point of view of physical geography, a mere western continuation of Siberia, and, as we travel southwards and westwards from Petschora land, we pass through a country whose surface-deposits are continuous, and of the same texture and having the same contents, the only difference being that the permanently frozen soil with its preserved animal mummies gives place to soil not permanently frozen, containing only skeletons; and this goes on in Russia right up to the deposit where the so-called Northern Drift begins to appear. In Siberia, where no Northern Drift occurs, the continuity of conditions goes on uninterruptedly until we reach the hilly districts of the South, where the Pleistocene remains are less frequent, but precisely the same in character, and they only disappear when we reach the widely-scattered sandy deposits containing salt-water shells, which are the evident bed of the dessicated Central Asiatic Sea of Pleistocene times.

The view here urged is, I believe, the view of Professor Nikitin and the most experienced Russian geologists.

In regard to Germany and Central Europe, Penck has devoted a special Memoir, entitled "Der Mench und Eiszeit," to show that Palæolithic Man and his companions were occupying that area while the so-called Ice-age was culminating in more Northern latitudes. In the Map in which he gives the various localities where traces of Palæolithic Man have occurred in Central Germany, he does not give one where the actual Drift occurs. It would be, indeed, singular if such a trace had, in fact, been found in that area, when we remember the rarity of the occurrence of the Pleistocene beasts in the same district; but he gives several in the zone bordering the actual Drift-zone on the south, and occupied by Loess, which is very generally accepted now as a flood-deposit closely united with

the Drift. Penck says that the synchronism of Palæolithic Man with the great Ice-age does not rest on a chain of different inferences, and he concludes his detailed examination of the problem with the words, "die ältesten Spuren des Europäischen Menschen gleichalterig sind mit den Moränen der Vergletzerungen."

The same view on different grounds has been urged by the distinguished botanist Drude, who argues that a considerable vegetation survived on the high ground in Germany, while the low ground was occupied by ice, and that it was from this vegetation the present flora of the country is derived.

If we turn to America and examine the problem, either as presented by the so-called Bone Licks of Ohio or by the Driftless areas, we shall be constrained to the same conclusion. The bones of the extinct animals in both cases occupy the very latest beds and are found, so far as we can judge, at the precise horizon where elsewhere the Drift beds occur. Whitney, who described the Driftless region in Wisconsin, Iowa and Minnesota, says that it "must have formed an island at the time when the great currents from the North were bringing down the detrital materials which are spread over so vast an area in the Northern hemisphere." Of the condition of this island and its environs, Mr. J. Geikie says: "Throughout this remarkable region the remains of numerous extinct Mammalia have again and again been detected. They occur promiscuously embedded in the surface-wash, or in cracks and crevices of the limestone. The animals mentioned are Mastodon, Megalonyx, Elephant, Buffalo, Wolf, extinct species of Peccary, Racoon, and several Rodents, etc. Many of these were got in clayey loam at considerable depths from the surface. . . . . Beyond the Driftless region, however, in those tracts that are thickly covered with gravel sand, boulders and hardpan, no such Mammalian remains occur in superficial or post-Glacial deposits" (Great Ice-Age, p. 464).

The evidence then of those areas where the Pleistocene beasts occur, but not the Drift, confirms that of those places where the Drift occurs but not the animals.

Lastly, we have to deal with that zone where both occur and where, so far as I know, the Drift always overlies the Mammoth beds when the latter are *in situ*. Here we find precisely what we should expect to find if a great diluvial movement had distributed the materials formed in the glaciated highlands, and the very reverse of what we should expect to find if the Drift had been distributed by ice. The rush of waters as it went along would seize upon the loose *débris* and incoherent beds from every district which it passed over, and incorporate them with the mud and other loads which it was carrying along. Thus we find molar teeth and other bones of Mammoth, etc., which must have been lying about in a fresh unweathered condition, and we find logs of timber occurring in the Boulder-clay itself and in the associated beds, and occurring there, no doubt, as true boulders, just as we may find Ammonites from the Lias and Oolitic fossils, together with masses of granite and other primitive rocks in the Boulder-clay of the Eastern Counties. Thus

we find in the Baltic lands marine shells associated with land *débris*, as we, in fact, do also in England where Molluscs from salt-water and Molluscs from fresh-water and pieces of wood, and teeth of animals occur in the same beds, being the *débris* of a widespread ruinous flood. It seems to me that all the evidence we have points to this conclusion, which I have long ago urged. The theory of the survival of the pre-Glacial Fauna and Flora is a notion that does not date from yesterday only. It is likely, I think, to grow. I have already shown in your pages what strong grounds there are for believing that the fauna and flora of Greenland, Spitzbergen, and other lands are not a re-importation after they had been depopulated by the Glacial monster, but a survival from pre-Glacial times.

Coming down to our own latitudes I never could understand how the Lusitanian forms in the flora of the South-West of England and the South of Ireland could be explained by any other theory.

The view had already been maintained by Edward Forbes. He considered that the oldest vegetation in the British Isles is that of the mountains of the West of Ireland, which, though an Alpine flora, is Southern in character, and quite distinct, as a system, from that of the Scotch and Welsh Hills. Its very Southern character, its limitation, and its extreme isolation, are evidence, he says, of its antiquity, pointing to a period when a great mountain-barrier extended across the mouth of the Bay of Biscay, from Spain to Ireland, which he attributes, hypothetically, to Miocene times. Another flora, confined to the South-west of England and uniting that promontory, is similar to that of the Channel Islands and the opposite coast of France. The existence of this flora depended upon the existence of a barrier, the traces of which still remain, from the West of France to the South-west of Britain. Here, again, we must travel beyond the Glacial period to explain the facts. Forbes argues further that the endemic animals, especially the terrestrial Molluscs, necessitate the same conclusion (Brit. Ass. Rep. for 1845, pp. 67 and 68).

Mr. Bulman has recently examined the question in Natural Science, and I will quote some of his conclusions.

He mentions the absence from England of fifty species of Mammals occurring on the Continent as a notable fact in this behalf, and pointing to our fauna being that which survived from Glacial times. If there had been a subsequent bridge it is hard to explain this absence, for, as he says, the supposition that they had not time will not pass muster; and so with the reptiles. Turning to the plants, he says that those which must have crossed the plain, on the hypothesis of a re-stocking from the Continent after the Glacial epoch, include, apparently, some of the most slowly-spreading forms. In regard to the Southern plants in Ireland, he says: "In the absence of a direct land-connection between Ireland and the North of Spain since glaciation, for which there is no independent evidence, it is difficult to understand how they can have got there;" and he goes on to argue "that a more reasonable explanation is to suppose that they were previously widely dispersed over Britain

and that they were exterminated everywhere, but in the warmest corner, by the cold." In regard to the Southern Flora of Devon and Cornwall the same writer says: "The precarious foothold of many of the species, and the apparent dying out of some, are not suggestive of species migrating northwards in response to a continually ameliorating climate." Lastly, Mr. Bulman quotes the occurrence of the reeds of *Naias marina* in the Cromer Forest Bed. The only British locality for this plant is Heckling Broad, Norfolk, and, hitherto, the Forest bed is the only fossil locality. "It would be," he says, "to say the least, a curious coincidence if it had been exterminated by the ice and had then re-migrated from the Continent to one spot in Norfolk only." The species is at present a native of the temperate and tropical regions of the world (Natural Science, pp. 261–266).

Dr. Scharff has recently sent me some papers on Irish land and fresh-water Molluscs, in which he takes the same view in regard to Ireland, and it seems to me it is only by taking this view we can explain the fauna and flora of the detached islands off the British coast.

Mr. Somervail thus describes the conditions which he supposed, and what I suppose, prevailed in Scotland during the Glacial age. "All the higher part of the country would appear to have been covered with snow and ice to a considerable depth. The great valleys were filled with glaciers which reached the sea. Large tracts of the country were entirely free from ice and covered with the flora and tenanted by the fauna already referred to, and doubtless by many more of whose existence we have not as yet discovered any record. Over certain tracts small lakes existed, formed by the melting of the terminal portion of the glaciers further inland, while in and around those lakes sufficient vegetation grew to form the layers of peat which we sometimes find inclosed in the Boulder-clay" (Trans. Geol. Soc. of Edinburgh, vol. iii. p. 95).

In illustration of this position, I would quote what is actually occurring in these Northern latitudes at this moment.

Speaking of a glacier near Odde on the Hardanger Fiord, Mr. J. M. Wilson says: "The steep slope of ice terminates in a very small moraine a yard or two wide . . . . masses of fresh turf, with flowers still in bloom, are thrown up in this moraine as the inexorable mass pushes on. It is now ploughing through the sweet pastures belonging to a farm. Within a few yards of the glacier are to be found wild roses and foxgloves, ladies' mantles and holly fern, and a score of meadow flowers, with ripe raspberries and strawberries and blackberries. This is a new glacier only 50 years old." (Geol. Mag., 1872, Vol. IX. p. 484).

The fact is, we have been pursuing a Will o' the Wisp instead of a real induction in following the lead of the cultivators of the great Glacial Myth. We must countermarch, that is plain; we must get rid altogether of the notion that half the Northern temperate zone was swathed in ice and snow, and realize it as it may be still realized in New Zealand, in the Himalayas, and the Altai Mountains, where glacier and forest are almost conterminous.

This view does away entirely with those theories according to which England, etc., etc., were stripped of their verdure and their living inhabitants and encased in a suit of frozen armour, and were then re-invaded and re-peopled by fresh importations of plants and animals which had meanwhile retired goodness knows where, and which returned again goodness knows whence, without having varied, in a mode at once simple and astounding.

The living plants and animals of these islands, with the exception of a very few extinct forms, are virtually the same as those living in the Mammoth age. It would have been strange indeed if this identity had survived an extinction of life and re-colonization of Britain. As a matter of fact, this extinction and this re-colonization are unsupported by any induction from the facts of either Geology or Natural History. They are, like many other scientific opinions, conclusions necessitated by adopting *à priori* theories. Some plants and some animals perished, no doubt, but the great bulk remained.

In discarding this conclusion we are remitted to a more rational one, namely, that the plants and animals found within our four seas, save and except those introduced by human agency, either directly or indirectly, and some waifs and strays, are the descendants of the plants and animals which were living here in the Mammoth age, which was the age of Great Glaciers, with which age the present one is, in fact, perfectly continuous, the only break having been the extinction of a few forms by the great catastrophe. This view is not popular just now, but I have no doubt whatever that it will presently prevail, and that its acceptance will clear away a great deal of difficulty and misleading intricacy from our text books, not only of Geology, but of Natural History.

The view here urged in regard to the contemporaneous existence of the Great Glaciers and a fertile champagne country side by side in the last Geological age seems to me to best explain the facts.

P.S.—I have just seen Mr. Stirrup's paper in the February Number, pp. 80–82. I am bound to say I cannot follow his logic, nor can I understand what he is after. The facts he quotes from Dall and others are well known. I do not dispute. What I do dispute is the inference that they point to the Ice beds being older than the Mammoth beds. Whatever their age, it seems to be quite certain that they must be the result of infiltration, unless trees can grow on blue ice and Mammoths browse on snow.

IV.—Further Remarks on the Tertiary (Eocene) Insects from the Isle of Wight, and on others from the Lias and Coal-Measures.

By the Rev. P. B. Brodie, M.A., F.G.S.

I WISH to make some corrections and additions to my recent paper on the Tertiary insects from Gurnet Bay, and to mention others from older formations. I have recently had an unexpected and gratifying visit from my friend Mr. Scudder, the eminent American palæo-entomologist, and if I had been aware sooner

of his coming to England I should have deferred my notice of some of our British Tertiary Arthropoda until he had examined the large and varied series in my Collection. Unfortunately, he could only spend a part of two days, so that the examination was very cursory; and, of course, it would require a very long and careful examination to determine them. He thinks that the supposed eggs of insects and annelids cannot be referred to either; the former he could not identify and the latter he considered to belong to plants. Among the insect remains he detected the following:—

(1) Coleoptera.

Curculio.
Staphylinus.
Cheironomus.
Boccus (allied to).
Elater Buprestidæ.
Telephoridæ, and many others.

(2) Hymenoptera.

Ants, several genera, very numerous.
Gnats, abundant.

(3) Lepidoptera.

Moth, with body and wings. A rare and very fine specimen.
Butterflies, two wings.

(4) Diptera.

Tipula, Crane fly, body and wings.
,, Wings.
Syrphidæ, several; and many others.

(5) Neuroptera.

Termites, nearly perfect, with attached wings, several.
Dragon-fly, part of, including head, thorax and one wing; several other wings.
Phryganea, wings.

(6) Orthoptera.

Locusta, wings.
Gryllus, wing.

(7) Hemiptera.

Aphis.
Cicada, wing and bodies.

(8) Arachnida.

Gastypus Woodwardii, and many others; one resembles *Epira* of Heer (P.B.B.).
Myriapoda, one example.

Among the Lias insects Mr. Scudder noticed an example of *Palæotermes*, unfortunately ill-preserved and imperfect, but it is desirable to record this genus from the Warwickshire Lias, as it may be identical with the fine and perfect insect from Barrow-on-Soar, described and figured by Dr. Woodward,[1] half of which is now in the British Museum (Natural History). In the Upper Lias, from Dumbleton, Gloucestershire, he noted two large *Neuropterous* wings as being quite distinct from *Libellula Brodiei*, the finest insect in my Collection, and to which they had been previously assigned. In the Coal-measures at Commentry, in France, there is a gigantic wing of a large, probably *Neuropterous*, insect, *Meganeura mongi*, Brongniart, the head and body of which are gone, except a thoracic portion to which enormous wings are attached. These are very long, longer than broad, with an expanse of wing almost approaching to that of a fair-sized bird. This is a most marvellous Carboniferous insect, the largest known and larger than the wing *Archæoptilus ingens*, Scudder, in my Collection, from the Coal Beds, Chesterfield, Derbyshire, showing how favourable the conditions must have been for the growth and development of certain forms of insect life in that epoch. Since then the *Neuroptera* and *Blattida*,

[1] Geological Magazine, Decade III. Vol. IX. p. 193, Pl. V. 1892.

so characteristic of the Coal-measures, seem to have degenerated. Many other Carboniferous insect relics are of great size, so that they must have been dinosaurs of their kind, and the *Neuroptera* became aldermanic and got fat and bulky on the well-grown and unctuous *Blatta*. A plate of this fine insect, kindly presented to me by the author, will appear in M. C. Brongniart's folio work on the Commentry insecta, in due course.

V.—Cordierite in the Lake District.

By Alfred Harker, M.A., F.G.S.

In the February Number of this Magazine, Mr. Hutchings announces that he has identified as Cordierite the mineral which constitutes the conspicuous "spots" in the metamorphosed slates of Wasdale Beck near the Shap Granite. In this connection, it may be of interest to record another occurrence of the same mineral, discovered by Mr. Marr and myself a year or two ago. It is in the metamorphosed Skiddaw Slates of the Caldew Valley in Cumberland, the locality of our specimens being south-west of the farm of Swineside. The cordierite occurs there in crystals of quite irregular shape, charged with various inclusions, original and secondary, and stained with limonite. A transverse section is about ·07 or ·08 inch in diameter, and shows the characteristic polysynthetic twinning, causing a division into six sectors when viewed between

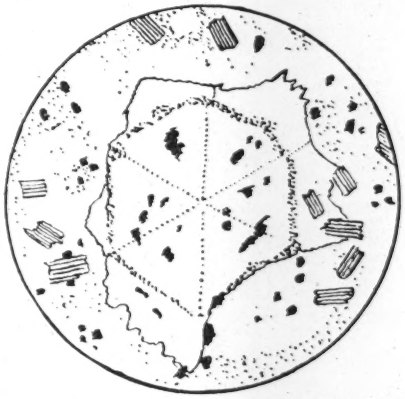


Fig. Transverse Section of Cordierite Crystal in the metamorphosed Skiddaw Slates near Swineside, × 20 [slide 1563].

The drawing is in part diagrammatic, the division into six fields being, of course, invisible in natural light.

crossed nicols. In addition there is a division into an inner and outer portion by a well-marked hexagonal zone of opaque, probably carbonaceous, inclusions. The outline of the transverse section itself shows only a general correspondence with the hexagonal form, and extends as a ragged fringe into the surrounding part of the rock.

The mineral recalls in some respects that described by Kikuchi[1] from the Waterase-gawa district in Japan; but it is not possible to make out in the Caldew occurrence all the interesting peculiarities exhibited by the much larger, fresher, and more perfect crystals studied by that author. He regards the variety which he describes as bearing the same relation to cordierite that chiastolite does to andalusite.

After Mr. Hutchings' discovery, it seems probable that cordierite will be found, if looked for, in other tracts of metamorphosed slates in this country.

VI.—Jurassic Ammonites: Notes on a Pamphlet by Dr. Emle Haug.[2]

By S. S. Buckman, F.G.S.

In the twentieth volume of the Bulletin de la Société géologique de France (p. 277) a valuable paper with the above title was published. It contains three plates with a number of species, six of which are said to be new. That I cannot agree with all his conclusions Dr. Haug knows well, for, before the work appeared, the author kindly sent me copies of his proof plates for my opinion, and several letters passed between us on the subject; that he cannot agree with all my opinions on matters palæontological the author readily confesses in the present paper. Nevertheless in two cases of importance this paper does bring us more closely into agreement, as I will point out presently.

In plate viii., the first of the three plates which illustrate the work, figs. 1 and 2 are called "*Sonninia*, cf. *corrugata*, Sowerby," figs. 3 and 4, "*S. furticarinata*, Quenstedt," fig. 5, "*S. pinguis*, Roemer," fig. 6, *S.* (*Poecilomorphus*) *Schlumbergeri*, n. sp." I certainly do not agree with placing figs. 3 and 4 in the same species: the latter figure shows a more coarsely-ornamented shell, its periphery furnished with a large hollow carina *not* bordered by anything like sulci, while the periphery of fig. 3 is very distinctly so marked. With fig. 4 I should associate, not necessarily as the same species, but as something very near, figs. 1 and 2; and I should also place in proximity fig. 5, "*Sonn. pinguis*." Roemer is the author of the name *pinguis*, and, though he gave a very bad figure of his shell, I think Haug's fossil is far too strongly costate; my cabinet can show specimens much nearer the original.

Of fossils nearly, if not quite, the same as fig. 3 I have several, and can say that, with age, they do not lose their peripheral furrows, that they do not become strongly lobate like fig. 4, and that they are certainly thinner.

Plate ix. shows "*Sonn. sulcata*, (S. Buckm.);" in removing this species from *Lillia* I think Dr. Haug has rightly corrected me, though the form he figures differs in certain points from mine—

[1] On Cordierite as a contact-mineral, Journ. Coll. Sci. Imp. Univ. Japan (Tokyo), vol. iii. (1890), pp. 313–334, pl. xxviii.

[2] Études sur les Ammonites des Étages moyens du Système jurassique.

Sonn. Buckmani, n. sp., an allied form, for which I tender my thanks—"*S. deltafalcata*, Quenstedt,"—and *Witchellia punctatissima*, n. sp.

Plate x. illustrates *S. alsatica*, Haug, now figured for the first time—a small *S. deltafalcata* which possesses connate ribs, and is thus different from those in pl. ix—"*Witchellia complanata*" and "*W. liostraca*, Buckm.," with the specific determination of which I agree, but which I placed in my genus *Dorsetensia*—"*Witchellia regrediens*,"—"*W. Edouardiana*,"—"*W. crassicarinata*," which looks dangerously like what I should expect to be the young of my *Dorsetensia tecta*,—"*Harpoceras capillatum*, Denckmann,"—and "*H.* cf. *aalense*," an interesting species from the "*Concavum*-zone," which has ribs far too falciform for close connection with *aalensis*.

My genus *Dorsetensia* Dr. Haug has rejected: he merges it in *Witchellia*, on the ground that *Witchellia* only differs from *Dorsetensia* by the persistence, in adults, of two furrows, one each side of the carina. This difference, he contends, is not sufficient for a genus, or even for a sub-genus; but with this dictum I venture to disagree: in my opinion any one character common to several species is of generic importance, provided it be not the result of homoplasy.

I fear that a certain misunderstanding of my genus *Witchellia* is answerable for Haug's rejection of *Dorsetensia*: the author could not find "lateral tubercles" in any *Witchellia*. Now, soon after founding my genus, I wrote that some specimens showed sharp spines in the inner whorls.[1] The phrase "sharp spines" is stronger than "lateral tubercles"; and in face of this distinct assertion the author's remarks appear a little rash. The question which occurs to my mind is: Do any of the specimens which he possesses belong to my genus *Witchellia* as I should define it? On this point I think there may reasonably be some doubt; because the only species which I recognize as having any likeness to *Witchellia* is his fig. 3, pl. viii.; but this the author calls "*Sonninia*."

Dr. Haug says that my *Dorsetensia pulchra* is d'Orbigny's *Edouardiana*, and my *Edouardiana* he names afresh, "*regrediens*." I am willing to admit that, *Edouardiana* being a French species, the author ought to know more about it than I do; but, if he be correct in these statements, d'Orbigny's must be a very unfortunate drawing. My *pulchra* is practically smooth half-a-whorl sooner than the specimen shown in d'Orbigny's figure of *Edouardiana*; while, further, my *pulchra* shows in its septation the very character—a two- instead of a three-pointed superior lateral lobe—which Haug calls attention to in his *regrediens* as a distinction from *Edouardiana*.

Among the many points of interest in this work I notice one thing with satisfaction, namely, that Dr. Haug now agrees with my view as to the position of *Witchellia*:[2] he places it as "un genre voisin du genre *Sonninia*." Formerly he regarded the species now known as *Witchellia* (+*Dorsetensia*, etc.) as allied to *Grammoceras*;[3]

[1] Descent of *Sonninia*, etc. Q.J.G.S. vol. xlv. p. 658.
[2] *Ibid.* p. 658.
[3] Beiträge Monogr. *Harpoceras*, Neues Jahrbuch für Mineral, etc. 1885. Beil-Bd. iii. p. 637.

but we have had some correspondence on this matter, and I take it as a compliment that the author can adopt my view. The change means a great deal: it signifies the removal of *Witchellia*, etc., from the family *Hildoceratidæ* into the family *Amaltheidæ*, sub-family *Sonninininæ*.

A notice of this pamphlet would not be complete without mentioning that it contains some interesting remarks about that sexual dimorphism among *Ammonites* which Prof. Munier-Chalmas has ably discussed.[1] The idea, though not novel, is certainly worthy of attention in the form it is now presented to us. I confess, however, to feeling considerable scepticism in the matter, though I have every wish to fully examine the evidence from the author's point of view, so as to do the idea full justice. MM. Munier-Chalmas and Haug evidently do not endorse the saying "*cherchez la femme*," but believe it to be necessary *cherchez le mâle*; and they think they have found him *chez les Ammonitidés*.

In concluding my remarks on this valuable contribution to Ammonite literature, I may note that the plates and many of the septal delineations are done by photography; and that on the whole the results are good.

P.S.—Since the above was written I have found that the proof-plate of *D. Edouardiana* was submitted to Dr. Haug; and that he agrees with my identification. It may be, of course, that in this matter "second thoughts" are best; I only mention it to show that I did not rely solely on my own judgment in the identification of a foreign species, but that I took the pains to get my opinion confirmed by one who is a competent authority.

REVIEWS.

I.—Palæontology of New York, Vol. VIII. Part II. Fascicle II. An Introduction to the Study of the Genera of the Palæozoic Brachiopoda. By James Hall, assisted by John M. Clarke, Albany, New York, December, 1893. Pp. 177-317, 95 Woodcuts. (Charles Van Benthuysen & Sons.)

THIS is another and welcome instalment of Hall and Clarke's remarkable work on Brachiopoda. It treats of the earliest forms of the Rhynchonelloids, Terebratuloids and Thecidoids, and therefore concludes their valuable generic discussions upon the Palæozoic Brachiopoda.

The authors are convinced that the primitive Rhynchonelloids deviated at an early age from the same stock whence *Orthis* had been derived. They state that the earliest Rhynchonellas of which the internal structure is known are not *Rhynchonellas* in any true sense (of the type of the Jurassic *R. loxia*), "but properly connecting morphological phases between *Orthis* and *Rhynchonella*—inceptive stages of the fuller development attained in later faunas."

[1] Munier-Chalmas. Sur la possibilité d'admettre un dimorphisme sexuel chez les Ammonitidés. Compte-rendu sommaire des Seances de la Société géologique de France, No. 14, p. 172. 1892.

The following new genera representing intermediate stages of structure are proposed for the Palæozoic Rhynchonelloids and Pentameroids:—

PROTORHYNCHA: type *Atrypa dubia*, Hall, Chazy limestone, a primitive and prolific form related to *Orthis*.

ORTHORHYNCHULA: type *Orthis Linneyi*, Nettelroth, Hudson River group, described "as a platystrophoid orthid and the closest link between the two groups."

CAMAROTŒCHIA, nom. nov., is founded on the *Rhynchonella congregata*, Conrad, from the Hamilton group.

The type, PUGNAX, sub-genus nov., is the *Conchyliolithus anomites acuminatus* of Martin, from the Carboniferous limestone. CYCLORHINA, gen. nov., type *Rhynchospira nobilis*, Hall. SYNTROPHIA, gen. nov., type *Triplesia lateralis*, Whitfield, from the Calciferous shales. PARASTROPHIA, type *Atrypa hemiplicata*, Hall, from the Hudson River group.

Linne's name *Conchidium* is restricted to plicated shells of the type of *Conchidium biloculare=Pentamerus conchidium* of Dalman from the Upper Silurian of Gothland. In America the species appears in the fauna of the Niagara shales. That of PENTAMERUS, Sby., is retained for smooth species without a sinus of the type of *Pentamerus lævis*. BARRANDELLA, is proposed for such Pentameroids as have the position of the median fold and sinus the reverse of those of *Rhynchonella*. CAPELLINIA is founded on a new species (*C. mira*) from the Niagara dolomites of Wisconsin which is "virtually" a reversed form of *Pentamerus oblongus*. The genus *Amphigenia* is regarded as a passage form between the Pentameroids and the Terebratuloids.

The discussion of the true Terebratuloids commences with that of the primitive type of the genus *Renssællaria*, which also unites some Pentameroid features with a brachidium resembling that of *Centronella*. "Anything more simple than the triangular loop of *Renssællaria* would be only the discrete processes of *Amphigenia* and the Rhynchonelloids."

The new sub-genus BEACHIA, based on *Renssællaria Suessana*, Hall, defines certain minor loop modifications. The names ORISKANIA, SELENELLA distinguish other variations of the Centronelloid loop. ROMINGERINA is applied to species of the *R.* (*Terebratula*) *Rominger* type, having spinulose or fimbriated loop margins. Bayle's name TRIGERIA is revived for the plicated Centronelloids like *C. Guerangeri*, de Verneuil. The Devonian genus *Cryptonella* is held to be a direct ancestor of *Magellania*. EUNELLA is the name applied to a variety with anterior apophyses broader at the base. A spinulose Cryptonelloid loop, distinguished as *Hartina*, is founded on *Centronella* (*Harttina*) *Anna*, Hartt.

The term *Cranæna* defines a Devonian variety of the Dielasmoids, somewhat intermediate in structure between *Cryptonella* and DIELASMA, and represented by *T. Romingeri*, Hall; *Cryptonella Iowensis*, Calvin, and "probably some other American species." The name of *Beecheria* compliments similiarly Dr. C. E. Beecher and is applied to a smooth

variety of Waagen's genus *Hemiptychina*, type *B. Davidsoni*, sp. nov., Hall, from the Carboniferous limestone of Nova Scotia. Hall's old genus *Tropidoleptus*, 1859, maintains its position as a Terebratuloid and is now regarded "as an early representative of the important family of the *Terebratellidæ*."

The exact relations and origin of those overgrown plicated Centronelloids from Bolivia, three inches and a half long, which were named *Scaphiocœlia* by their describer, Whitfield, remain obscure, and the origin of the gigantic Stringocephalæ is still veiled in mystery. The latter, so abundantly developed in the Middle Devonian of England and Germany, have been recently discovered in the same horizon by Whiteaves in the Mackenzie River Basin of British North America.

The systematic position of the genera *Eichwaldia*, *Aulacorhynchus* the authors leave undetermined. *Lyttonia*, *Oldhamina*, and *Richthofenia* are somewhat doubtfully regarded as Palæozoic forms of the family *Thecididæ*.

Here terminate the authors' valuable generic discussions upon the Palæozoic Brachiopoda; some of the results of their critical researches have been already tabulated in Mr. Charles Schuchert's "Classification of the Brachiopoda." A final chapter on the vexed question of the classification of the genera is, however, promised by Professors Hall and Clarke, to be issued with the requisite indices to the second volume and sixty quarto plates (from xxi. to lxxxiv. inclusive), thus completing this great undertaking. Its appearance is awaited with interest as the coping-stone to a monumental work which, taken as a whole, must be regarded as the most suggestive and important production of the century concerning the general History of the Brachiopoda. It forms the natural outcome and most important manifestation of the value of the methods of the correlations of Ontogeny and Phylogeny[1] as practised by Hall, Clarke, Deslongchamps, Beecher, and the Œhlerts. It is mainly from the results obtained by these combined lines of research that we owe the enlargement of our knowledge of the evolution of the Brachiopoda—a progress too real and stable to be denied by any serious student of the recent literature of this group of organisms. To this subject we hope before long to revert.

AGNES CRANE.

II.—LOWER CARBONIFEROUS CRINOIDEA FROM THE HALL COLLECTION NOW IN THE AMERICAN MUSEUM OF NATURAL HISTORY, WITH ILLUSTRATIONS OF THE ORIGINAL TYPES. By R. P. WHITFIELD. "Memoirs of the American Museum of Natural History," Vol. I. Part I. 4to. pp. 1–37, three Plates. 1893.

THIS, the first number of a new series of Memoirs of the American Museum of Natural History, is devoted by Mr. R. P. Whitfield, Curator of Fossil Invertebrata in the Museum, to a

[1] The most recent addition to our knowledge of this subject was a contribution by Dr. C. E. Beecher to the American Naturalist for July, 1893, entitled, "Some Correlations of Ontogeny and Phylogeny in the Brachiopoda."

republication of Prof. Hall's descriptions and diagrams of the Lower Carboniferous Crinoidea with additional comments thereon and three fine plates of the type specimens, some of which are now illustrated for the first time. The text, intercalated by numerous cuts, treats of the *Platycrinidæ*, *Actinocrinidæ*, *Cyathocrinidæ*, and a blastoid (*Orphocrinus Whitei*) from the Burlington Limestone of Iowa, Missouri, and Illinois and the Keokuk Limestone of Iowa. Mr. Whitfield follows Messrs. Wachsmuth and Springer's "Revision of the *Palæocrinidæ*" in generic nomenclature, but takes the opportunity to rectify some misapprehensions in regard to certain types chiefly arising from the fact that Prof. Hall's original descriptions, published, it should be remembered, thirty-four years ago, were not always accompanied by figures of the specimens. Some of his species have consequently been merged in genera and species of later authors. This publication is, therefore, somewhat of a reclamation of types, and will be followed by others of a similar nature giving descriptions and full illustrations from the magnificent series of invertebrate types in the Hall collection exhibited in the well-lighted galleries of the American Museum of Natural History of New York City. A. C.

III.—The Mean Density of the Earth. An Essay to which the Adams Prize was adjudged in 1893 in the University of Cambridge. By Prof. J. H. Poynting, D.Sc., F.R.S. Pp. i.—xix. 1–156, 7 plates. (London, 1894.)

THE subject for the Adams Prize in 1893 was "The methods of determining the absolute and relative value of gravitation and the mean density of the earth," and the essay which gained the prize is here published in accordance with the conditions of the award. Several additions have, however, been made since it was first written. A bibliography containing the titles and summaries of 45 memoirs has been prefixed. Part I., which is an account of all the experiments so far made, has been slightly enlarged. Part II. is unaltered, and is simply a reprint of the author's memoir communicated to the Royal Society in 1891, in which he describes his own determination made by means of the common balance.

In the historical discussion the geologist will find much to interest him. The accounts are full but concise, and in each case end with criticisms, which derive much of their value from being so often the results of the author's own experience. The experiments naturally fall into two classes: (1) those in which the attracting mass is a portion of the earth's crust; and (2) those which are carried on in the laboratory, the attracting mass being small, easily handled, and of more uniform density. With regard to the first class of experiments, the author concludes that "our knowledge of the distribution of the terrestrial matter is not yet sufficiently exact to enable us to obtain good values of the mean density of the earth from the observed attraction of terrestrial masses. Rather must we assume

the mean density from laboratory experiments, and use the observations of terrestrial attractions for the converse problem of determining the distribution of terrestrial mass." The whole part abounds with passages such as this, which, condensed as sentences from Bacon's Essays, might form chapter headings for many a work to come. It closes with the following "summary of results hitherto obtained:"—

Approximate Date.	Experimenter.	Method.	Result.
1737–40	Bouguer...	Plumb-line and Pendulum	Inconclusive
1774–76	Maskelyne and Hutton	Plumb-line	4·5 to 5
1855	James and Clarke... ...	,,	5·316
1821	Carlini	Mountain Pendulum ...	4·39 to 4·95
1880	Mendenhall	,,	5·77
1854	Airy	Mine Pendulum	6·565
1883	von Sterneck...	,,	5·77
1885	von Sterneck...	,,	about 7
1797–8	Cavendish	Torsion Balance	5·448
1837	Reich	,,	5·49
1840–1	Baily	,,	5·674
1852	Reich	,,	5·583
1870–	Cornu and Baille	,,	5·56 – 5·50
1889	Boys	,,	in progress
1879–80	von Jolly	Common Balance	5·692
1878–90	Poynting	,,	5·493
1884–	König, Richarz and Krigar Menzel	,,	in progress
1886–8	Uilsing	Pendulum Balance	5·579
1889	Laska	,,	in progress

With Part II. begins the more strictly original half of the essay, "A determination of the mean density of the earth and the gravitation constant by means of the common balance."

The principle of the method is as follows: Two equal masses A and B, are suspended one from each end of the beam of a very delicate balance. A large sphere M is brought first under the mass A, and then under the mass B. Its attraction being removed from A and added to B, it follows that the beam turns through nearly double the angle due simply to the attraction of M on one mass alone. Of course when M is under A it will at the same time attract B, and when under B it will attract A, and these cross-attractions must be taken into account. So also would the attraction of M on the balance-beam and suspending-wires have to be allowed for; but this operation (most difficult on account of their irregular shape) is avoided by repeating the experiment after raising the masses A and B through known equal distances, without altering the length or form of the suspending wires. It is evident that the attraction of M on the beam and wires is the same in both experiments, and the change in the attraction is therefore due only to the change in the distances of A and B from M. From this change in attraction, the attraction at any distance can be found.

The balance, whose beam is a little over 4 feet long, was erected

in a cellar at the Mason College, Birmingham, its foundation having no connection with the brick floor of the cellar. The turn-table, on which the attracting mass M rests, has also an isolated foundation separate from the former. The masses A and B each weigh about $47\frac{1}{2}$ lbs. and the mass M about 338 lbs., all three being composed of an alloy of lead and antimony of specific gravity 10·4. The distance between the centres of M and A or B is about $12\frac{1}{2}$ inches in the lower position of the latter, and about $24\frac{1}{2}$ inches in their higher position.

To magnify the tilting of the balance, a double-suspension mirror was used, similar to that employed by Messrs. G. H. and H. Darwin in their experiments on the lunar disturbance of gravity. The mirror is suspended by two eye-holes on a fine silk thread, one end of which is attached to a small bracket projecting from the lower end of the pointer of the balance, the other to a fixed bracket close to the former, so that the plane of the mirror is perpendicular to that of the balance. The distance between the points of support of the silk thread being $\frac{4}{5}$ of an inch, and the length of the balance-pointer 2 feet, it follows that the mirror turns through an angle 150 times as great as the balance-beam.

In the room over the cellar and close to a hole in the floor are the telescope, provided with cross-wires, and a scale illuminated by a lamp. The light from the scale is reflected by an inclined mirror in the cellar so as to meet the double-suspension mirror horizontally, is reflected by it and by the inclined mirror again, and returns to the telescope. If the balance-beam turns through a very small angle, the image of the scale seen in the telescope is shifted over the cross-wires. Two small riders, each weighing one centigramme, are arranged so that their points of support are on the balance-beam at a distance of one inch on either side of the knife-edge. One being raised from the beam, the other is lowered on to it, and the number of divisions of the scale corresponding to the deflection of the beam so produced is compared with the number of divisions corresponding to the deflection produced by the attraction of M being taken away from A and added to B. This ratio gives the increase in the weight of A or B due to the attraction of M when vertically below it.

It will be unnecessary here to enter further into the details of the experiment, or to describe the numerous precautions taken to ensure accuracy. The chief disadvantage of the method is that "the disturbances due to air-currents are greatest in the vertical direction, that of the displacement to be measured," and the larger the apparatus the greater are the errors produced by them. If the experiment were to be repeated, the author would make the apparatus small, for it could then be kept at a more uniform temperature and it would be more handy to adjust. "At the same time," he concludes in his characteristic manner, "it is only fair to say, on behalf of the large apparatus, that some errors have been magnified on a like scale till they have become observable, and so could be investigated and eliminated. Starting with a small apparatus they would

probably never have been detected, and would, therefore, have appeared in the final result."

The value obtained for the mean density of the earth is 5·4934, and will now no doubt take its place as the standard value. Sooner or later, perhaps, unsuspected sources of error may be pointed out, methods of greater refinement may be discovered, and the result just quoted may be superseded by others more reliable. For the present, one more "magnificent experimenter" has given the thought of years to a problem that lies just within our grasp, and we may well rest content with a work which is one of the best examples we have of the fine patience that ennobles science.

C. Davison.

IV.—The Seismological Journal of Japan, Vol. II. 1893 (corresponding to vol. xviii. of the Transactions of the Seismological Society of Japan): Edited by Prof. J. Milne, F.R.S.

(1) J. Conder. An architect's notes on the great earthquake of October, 1891: pp. 1–91.
(2) J. Milne. Abstract of a report [on the earthquakes and volcanic phenomena of Japan] to the British Association: pp. 93–109.
(3) E. von Rebeur-Paschwitz. On the observations of earthquake-waves at great distances from the origin, with special relation to the great earthquake of Kumamoto, July 28th, 1889: pp. 111–114.
(4) P. Mayet. On the five mile water-level: pp. 115–117.
(5) F. Omori. On the overturning of columns: pp. 119–122.

The first and last papers of this invaluable Journal are chiefly interesting to architects in earthquake countries. Prof. Milne gives an abstract of his last report to the British Association, the full text of which will probably be published and readily accessible before this notice appears. Dr. Mayet advocates the construction of the long water-level suggested by Prof. Milne in the first volume of the Journal, but the latter adds a note in which he prefers the erection of horizontal pendulums at what would be the terminal stations of the level.

In a short paper Dr. von Rebeur-Paschwitz introduces a subject of great importance. The severe earthquake of Kumamoto (Japan) occurred on July 28, 1889, at 11.40 p.m., Tokio time, or 2h. 20·9m., Greenwich time. At about 2·28 p.m. (G.M.T.) horizontal pendulums at Potsdam and Wilhelmshaven, in Germany, showed perturbations of moderate size and duration, and others, again, somewhat similar in character, at 6·6 p.m. Supposing the disturbance to have spread out from Kumamoto and travelled in opposite directions round a great circle of the earth to a point midway between Potsdam and Wilhelmshaven in the times recorded, the average velocities in the two directions must have been 2·2 and 2·3 kilometres per second respectively. The hypothesis thus agrees with the observed phenomena, but "we will have to depend on future observations to remove the last doubt about the possibility of earthquake movement being observable at enormous distances."—C. D.

V.—Proceedings of the Cotteswold Naturalists' Field Club for 1892–1893. Vol. XI. Part I. 1893.

THIS Part contains the address of the retiring president, Mr. W. C. Lucy, who gives an account of the work of the session, and of the excursions made to Woolhope, Bath, Cleeve Hill, and Newent. He refers in particular to the Drifts of the Cotteswold area, and also gives a section of the Coalfield near Newent.

There is, in addition, an elaborate paper by Mr. Etheridge "On the Rivers of the Cotteswold Hills within the Watershed of the Thames and their importance as supply to the main river and the Metropolis." This paper gives in detail much of the information brought before the late Royal Commission on Water Supply by Mr. Etheridge.

VI.—Handbook to the Collection of British Pottery and Porcelain in the Museum of Practical Geology. 8vo. pp. 178, with 132 Illustrations. London: Printed for Her Majesty's Stationery Office. Price 1*s*.

A NEW edition of the Catalogue of the Pottery and Porcelain in the Jermyn Street Museum has long been wanted. The Third Edition, by Trenham Reeks and F. W. Rudler, was published in 1876. The present work, which has been prepared by Mr. Rudler, is arranged so as to form a Handbook rather than a Catalogue. Thus the matter is arranged throughout in a readable form, with references only to particular specimens, instead of containing descriptions of all the objects on exhibition. The work is brought up to date by additional information, and thus forms an authoritative guide to the student.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—February 7th, 1894.—W. H. Hudleston, Esq., M.A., F.R.S., President, in the Chair. The following communications were read:

1. "On some cases of the Conversion of Compact Greenstones into Schists." By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

By the path leading from the Bernina Hospice to the Grüm Alp (Engadine) some masses of compact green schist are seen, intercalated in a rather crushed gneiss. They prove to be intrusive dykes modified by pressure. Microscopic examination of specimens from these reveals no trace of any definite structure indicating an igneous rock; a slice, cut from one of the masses within an inch or so of a junction, shows it to be a foliated mass of minute chlorite or hydrous biotite, with granules of epidote (or possibly some sphene) and of a water-clear mineral, perhaps a secondary felspar. An actual junction shows a less distinct foliation and some approach to a streaky structure. A slide from the middle of another dyke (about 18 inches thick) exhibits a more coarsely foliated structure and minerals generally similar to the last, except that it may contain

a little actinolite and granules of hæmatite (?), and the clear mineral, in some cases, seems to be quartz. The structure and most of the minerals appear to be secondary. Chemical analysis shows the rock to have been an andesite. A specimen from a third dyke is generally similar, but is rather less distinctly foliated.

A somewhat similar, but rather larger intrusive, mass by the side of the Lago Bianco shows more actinolite and signs of primary felspar, with other minerals. Here the rock retains some likeness to a diabase. The resemblance of certain of these rocks to somewhat altered sediments is remarkable. The author considers the bearing of this evidence upon other and larger masses of "green schist" which occur in the Alps, and expresses the opinion that their present mineral structure may be the result of great pressure acting on more or less basic igneous rocks.

2. "The Waldensian Gneisses and their Place in the Cottian Sequence." By J. Walter Gregory, D.Sc., F.G.S.

The lower part of the sequence of the Cottian Alps has been universally divided into three series, of which the lowest has been regarded as a fundamental (basal) Laurentian gneiss. It is the object of the present paper to show that this rock is really intrusive in character and Upper Tertiary in age. The writer endeavours to show this by the following line of argument:—(1) The gneiss consists of only isolated outcrops instead of a continuous band, and these occur at different positions and not always at the base of the schist series; (2) the gneiss is intrusive, because: (*a*) it includes fragments of the overlying series instead of *vice versâ*, (*b*) it sends off dykes of aplite into the surrounding schists, (*c*) it metamorphoses the rocks with which it is in contact, and (*d*) the schists are contorted near the junction; (3) the gneisses are further shown to be later than the igneous rocks intrusive into the "pietre verdi" series, as these never traverse the gneiss.

No positive opinion as to the age of the overlying schists is expressed in the paper, though it is pointed out that the recent discovery of radiolarian muds in the series may necessitate their inclusion in the Upper Palæozoic. The freshness of the gneisses, the fact that these have not been affected by the early Tertiary earth-movements, and the absence of authentic specimens of the gneiss in the Cretaceous, Eocene, and Miocene conglomerate, renders their late Tertiary age highly probable.

The nature of the contact-metamorphism and the origin of the gneissic structure are discussed, and a classification offered of the earth-movements in the Cottian Alps.

II.—Annual General Meeting.—February 16th, 1894.—W. H. Hudlestone, Esq., M.A., F.R.S., President, in the Chair.

The Secretaries read the Reports of the Council and of the Library and Museum Committee for the year 1893. In the former the Council congratulated the Fellows on the prosperous condition of the Society's finances, drawing at the same time attention to the continued decrease in the number of Fellows.

The number of Fellows elected during the year was 42; of these 33 qualified before the end of 1893, making, with 6 previously elected Fellows, a total accession of 39 in the course of the twelvemonth. During the same period the losses by death, resignation, and removal amounted to 85, the actual decrease in the number of Contributing Fellows being 24. The total number of Fellows, Foreign Members, and Foreign Correspondents at the close of 1893 was 1353, as compared with 1400 on December 31st, 1892, and 1418 on December 31st, 1891.

The Balance-sheet for the year 1893 showed receipts to the amount of £2750 18*s.* 10*d.* and an expenditure of £2204 17*s.* 6*d.* Moreover, the sum of £502 15*s.* 3*d.* was expended in the Purchase of Stock, and the balance in favour of the Society on December 31st, 1893, amounted to £371 5*s.* 11*d.* The invested Funds of the Society have now reached the sum of £10,729 11*s.*, and the Council state that they feel the time has now arrived when the question of safeguarding by investment the interests of Compounders may be re-opened.

The Report of the Council further referred to the completion of vol. xlix. of the Quarterly Journal, and in conclusion announced the awards of various Medals and proceeds of Donation Funds in the gift of the Society.

The Report of the Library and Museum Committee enumerated the additions made during the past year to the Society's Library, announced the completion of several sets of serials formerly imperfect, and referred especially to the large accession of British Geological Survey maps and memoirs. The Report further recorded the continuation of the work of registering the type and other specimens in the Museum by Mr. C. Davies Sherborn, F.G.S.

In handing the Wollaston Medal (awarded to Geheimrath Professor Karl Alfred von Zittel, For.Memb.G.S.) to Dr. Woodward, F.R.S., for transmission to the recipient, the PRESIDENT addressed him as follows:—Dr. Woodward,—

The Council of the Geological Society have this year awarded the Wollaston Medal to Geheimrath Dr. Karl Alfred von Zittel, Professor of Geology and Palæontology in the University of Munich, in recognition of the important services which he has rendered to palæontological science during a long period of time. Without alluding in detail to his early work on Austrian geology, much of which was published at Vienna, I wish to point out that, as Oppel's successor at Munich, he has continued to advance our knowledge of the Mesozoic fauna of Central Europe, and more especially of the interesting passage-beds betwixt the Jurassic and the Cretaceous; whilst the memoirs which he has published on these subjects derive additional value from their excellent illustrations.

Twenty years have now elapsed since K. A. von Kittel joined the expedition of Gerhard Rohlfs to the Lybian Desert, and his contributions to the geology of that region are probably the most important that have as yet appeared in relation to Egypt and the adjacent countries. It was on his return from this expedition that he commenced his *magnum opus*, 'The Handbook of Palæontology,' the first part of which was published in 1876 and the last part, relating to the Mammalia, in 1893, thus occupying an interval of 17 years' continuous labour. If proof were needed of the thoroughness of his work, we obtain it in his treatment of the fossil sponges, which he found in so chaotic a state that he applied himself to working out their relations independently, and, having discovered the key in the microscopic structure of their skeletons, was thus enabled to establish a system of classification which has been found equally applicable to recent forms.

It is scarcely necessary to remind you that our Wollaston Medallist has occupied the Chair of Palæontology at Munich for 28 years, during which time he has not only perfected the collections at the museum, but his personal teaching has attracted to his lectures students from almost all parts of the civilized world. I feel confident, therefore, that the selection of the Council will be cordially endorsed both by the Fellows of our own Society and by all, whether at home or abroad, who are interested in the brilliant record of one of the foremost palæontologists of the age.

Dr. Woodward, in reply, said:—Mr. President,—

I feel sure that no award of the Wollaston Medal made by the Council of this Society has ever been more popular than that made to Geheimrath K. A. von Zittel, and I only regret that his duties as Dean of the Faculty in his University, and his daily lectures, have prevented him from being present to receive the Medal in person. I shall, however, be happy to convey to him your kind expressions of appreciation for this work; and I beg permission to read to you, from a letter which I have received, the following message addressed to yourself:—

"With respectful thanks I acknowledge the unexpected honour with which the Council of the Geological Society has favoured me, in awarding to me the Wollaston Medal. I need scarcely say how highly I appreciate this distinction, conferred upon me by the most competent of scientific juries. I am really proud to have reached this highest aim for the ambition of every geologist, and I feel particularly pleased to find among the late and present possessors of the Wollaston Medal the name of H. G. Bronn, my first teacher in palæontology, and of Franz von Hauer, who directed my first steps in geological field observation.

"If, through conscientious labour, I have been fortunate enough to contribute somewhat to the promotion of our knowledge of Palæontology and Geology, I feel by your kindly recognition amply rewarded for all the pains that I may have taken in my scientific researches.

"I deeply regret that I am unable to thank you personally, Mr. President; but you may be sure that the honour you have bestowed on me will be a strong incentive to make myself more worthy of your confidence by further investigations in the wide field of Palæontology and Geology."

The President then presented the Balance of the Proceeds of the Wollaston Donation Fund to Mr. Aubrey Strahan, M.A., F.G.S., addressing him in the following words:—Mr. Strahan,—

The Council have this year awarded to you the balance of the Proceeds of the Wollaston Donation Fund, in token of appreciation of your geological work in several parts of England and on the Welsh Border. In solid geology you have especially distinguished yourself amongst the Carboniferous rocks of the Pennine Chain and of North Wales, whilst your contributions to our own Journal, on more than one subject in connection with the Mesozoic rocks, have evinced the interest that you take in questions arising within your own professional experience. The Glacial Drifts of the Welsh Border and the Glaciation of South Lancashire have also come under your notice in dealing with the difficult subject of Superficial Deposits. Beyond any mere assistance which the Balance of the Fund might render towards further research, the Council, by this Award, desire to express their sense of the value of the work which you have already accomplished.

Mr. Strahan replied as follows:—Mr. President,—

In thanking you and the Council of the Geological Society for this Award, I wish to express my deep gratification at being honoured by your selection.

During my connection with the Geological Survey I have, from the nature of the work, been engaged in so many different parts of the country that I have been unable to concentrate my attention on any one formation as closely as might have been the case, and have been led to consider some of the wider problems of geology. I trust, however, that my work has not been without service to those engaged upon the more minute zonal divisions of strata.

In every district in which I have been occupied, geologists with local knowledge have generously placed their observations at my disposal. The only return I could make lay in producing the results of my work as expeditiously and in as useful a form as possible. I take this Award as an indication that I have not been wholly unsuccessful.

In presenting the Murchison Medal to Mr. William Talbot Aveline, F.G.S., the PRESIDENT addressed him as follows:—Mr. Aveline,—

The Council have this year awarded to you the Murchison Medal, together with a sum of Ten Guineas, in recognition of the importance of your work as a geological surveyor. Nearly half a century has elapsed since your first communication to this Society, in conjunction with the late Sir Andrew Ramsay, on the structure of portions of Wales. Later on, we find you engaged in mapping and describing some of the Mesozoic Rocks of Central England, and it is now rather more than thirty years since you commenced your work on the Permian and Carboniferous of Nottinghamshire and Derbyshire. Still more recently you were engaged, as district surveyor, on the borders of the Lake Country, being associated with Prof. Hughes, Mr. Tiddeman, and other well-known geologists. That your supervision of the work then progressing has yielded excellent results in relation to the survey of that difficult region is a matter of notoriety.

Although it is some time since you retired from active employment I feel sure that you will be gratified to find that the record of former years is not overlooked by a generation of geologists who recognize the value of the work in which you had so large a share.

Mr. AVELINE, in reply, said:—Mr. President,—

It is with feelings of great gratification I receive this Medal, founded by my former chief, Sir Roderick Murchison, whose friendship and kindness I experienced during the time he was Director-General of the Geological Survey, and in whose company I made some very pleasant geological explorations.

I am very much pleased to think that my work on the Geological Survey has been appreciated by the Council of this Society, and that they should have thought me worthy of receiving this Medal.

Mr. President, I cannot let this opportunity pass without saying a word as to another Director-General of the Geological Survey, the distinguished successor of Sir Roderick Murchison – Sir Andrew Ramsay, who for over forty years was a sincere friend of mine, and to whom I owe so much for his ready assistance and advice when he was Director of the Geological Survey; we have together worked out many a knotty point in the geology of Wales and elsewhere, tramping together many a mile of mountain and valley. I am sure, if he were living now, he would have rejoiced at the honour this day conferred on me.

I must add that among the most pleasing results of receiving this Medal are the kind congratulations which I have received from my old colleagues.

The PRESIDENT then handed the Balance of the Proceeds of the Murchison Geological Fund to Mr. George Barrow, F.G.S., addressing him as follows:—Mr. Barrow,—

The Balance of the Proceeds of the Murchison Geological Fund has been awarded to you by the Council as a testimony of the value of your geological work both in Yorkshire and in Scotland. As regards the former district, I would draw especial attention to your description of the geology of North Cleveland. Since your transfer to the Survey of the South-East Highlands you have evinced a remarkable aptitude for petrological studies, whilst your recent paper in the "Quarterly Journal" on the Muscovite-biotite-Gniess of Glen Clova bids fair to rank high in that category. The Council hope that this mark of appreciation may not only aid but encourage you to further research in the same direction.

Mr. BARROW replied in the following words:—Mr. President,—

I beg to thank the Council for the unexpected honour that they have done me in conferring this Award. In receiving it at your hands, Sir, pleasant memories are revived of my early geological days in East Yorkshire, when your writings were of much assistance to me. In those happy times we had no difficulty in deciding which way up the succession lay. But now, in working on the Highland Series it is often difficult, if not impossible, to decide this very elementary point, and any kindly encouragement in such work is most welcome. It is the more welcome as in this case it is a recognition that my efforts so far are not entirely without value.

In handing the Lyell Medal (awarded to Prof. John Milne,

F.R.S.) to Prof. J. W. Judd, F.R.S., V.P.G.S., for transmission to the recipient, the PRESIDENT addressed him as follows:—Professor Judd,—

The Lyell Medal, with the sum of Forty-Six Pounds, has been awarded to Prof. John Milne, F.R.S., of the Imperial College of Engineering, Tokio, Japan, in testimony of appreciation of his investigations in Seismology. It must ever be regarded as a fortunate event, in the interests of science, when Prof. Milne went to reside in Japan. Undoubtedly his opportunities in that oscillating region have been great, but he has been fully equal to the occasion, and may with justice be regarded as the founder of seismic science in that country. His efforts in this direction are in part recorded in the annual volumes of the Seismological Society of Japan, to which he has always been one of the most important contributors. Stimulated no doubt by this good example, the Government of Japan has taken up the study of earthquakes by establishing some 700 stations for observations, so that, to use Prof. Milne's own words, "phenomena, which were formerly matters of hypothesis, are now no longer unexplained."

It is indeed the eminently practical turn given by Prof. Milne to the study of earthquakes which commends his work so effectually to geologists; and ever since his seismic experiments, in conjunction with Mr. Gray, and the reports published by the British Association on the investigation of the Earthquake Phenomena of Japan, Prof. Milne has been recognized as one of the leading authorities in this branch of science. Bearing in view, also, the delicate and costly nature of seismological apparatus, the Council feel justified in awarding a considerable sum of money, out of the Fund, to accompany this Medal.

Prof. JUDD, in reply, said:—Mr. President,—

Although I rise at short notice, it is with extreme satisfaction that I receive at your hands this Award to Prof. Milne. It was my good fortune to be acquainted with the recipient of this Medal and Fund before he left this country for Japan; and during his long residence in that distant land I have had the privilege of frequent correspondence with him. The cheerful courage with which he has faced unpromising surroundings, the resourceful tact with which he has met every difficulty, and the unconquerable energy with which he has surmounted the greatest obstacles, are known to all of us. You, Sir, have referred to the admirable work done by the Seismological Society of Japan, and it is not too much to say that during a long period Professor Milne might have justly asserted "I am the Seismological Society." The foundation of that Society and the Seismological Magazine are due to the wise foresight and the unflagging energy of Prof. Milne himself, and to the efforts of the pupils whom he has instructed, and whose enthusiasm he has fired. I feel assured that the Fund which you have asked me to place in his hands will be administered in the best interests of Geological Science. It was my good fortune to know, very intimately, the founder of this Medal and Fund, and I am persuaded that the Council of this Society never more truly fulfilled his wishes and never more fully conformed to the terms of his bequest—both in their letter and spirit—than when they decided to make this Award to Prof. John Milne.

The PRESIDENT then presented the Balance of the Proceeds of the Lyell Geological Fund to Mr. William Hill, F.G.S., and addressed him in the following words:—Mr. William Hill,—

The Balance of the Proceeds of the Lyell Geological Fund has been awarded to you in testimony of the value of your work amongst the Cretaceous rocks of this country during the last eight years. In collaboration with Mr. Jukes-Browne, you have made communications to this Society on the Upper Cretaceous strata of East Anglia, which are recognized as being of the highest importance. Similar investigations, moreover, were prosecuted by yourself alone with equal success in Lincolnshire and Yorkshire. Your intimate acquaintance with the lithological characters of the various members of the series has materially aided your stratigraphical and palæontological knowledge in arriving at correct results. It is hoped that this acknowledgment of your services to geological science may encourage you to continue your researches.

Mr. HILL replied as follows:—Mr. President,—

I desire to convey my heartiest thanks to the Council of this Society for the Award which you have just placed in my hands. My geological work has been undertaken chiefly to fill my spare time, and I feel my reward ample in the pleasure which geological study has given me, and in the kindly reception of my papers at the hands of this Society. The unexpected honour you confer is to me more gratifying than I can well express.

You have spoken of the value of my work, but I must not forget that this is much enhanced by the help which I have received from many Fellows of the Society, and especially from one who is not often with us. I take this opportunity of thanking them most heartily. I need hardly say, Sir, that the Award will stimulate me to further efforts in the cause of Geological Science.

In handing a portion of the Proceeds of the Barlow-Jameson Fund to Mr. Charles Davison, M.A., the PRESIDENT addressed him as follows:—Mr. Davison,—

A sum of Twenty-five Pounds from the Proceeds of the Barlow and Jameson Fund has been awarded to you in token of appreciation of your work in geological dynamics—including under that term the study of earthquakes. In this connection I would more especially allude to your valuable notice of the Inverness earthquakes of 1890, wherein your conclusions with reference to the Great Glen of Scotland open out views of the utmost importance in relation to the Highland faults. We are also indebted to you for calculations on the movement of scree-material, based on the expansion of the stones through heat.

Geologists, I may say, are always glad to receive assistance from mathematicians, and it is to be hoped that this acknowledgement on the part of the Council of the value of your work may have the effect of stimulating you to further study in that direction.

Mr. DAVISON, in reply, said:—Mr. President,—

If anything could add to the welcome and gratifying character of this Award, it would be the words of kindness and encouragement that have accompanied it. For both I beg to tender my sincere and hearty thanks. I have been told, Sir, and in my own case I feel sure that it must be so, that the Council in awarding these Funds look not so much to the past as to the future. I wish I could do more than assure the Council that my best efforts will be used to prevent their kindly hopes from being disappointed.

The PRESIDENT then proceeded to read his Anniversary Address, in which he first gave Obituary Notices of several Fellows and Foreign Members and Correspondents deceased since the last Annual Meeting, including Prof. John Tyndall, Prof. Charles Pritchard, Mr. Thos. Hawksley, Mr. James W. Davis, Mr. Edward Charlesworth (elected in 1835), the Rev. Leonard Blomefield (elected in 1835), the Rev. W. H. Crosskey, Mr. H. M. Becher, Count Alexander von Keyserling (deceased 1891), Prof. Juan Vilanova y Piera, Prof. K. A. Lossen, Herr Dionys Stur, and Prof. Pierre J. Van Beneden. The other portion of the Address may be summarized as follows:—

In continuation of the subject of the preceding Anniversary Address, relating to some recent work of the Geological Society, the remaining portion of the paper contributed within the septennial limits is classified under two groups. In the first group are placed papers descriptive of the Newer Palæozoic Rocks, the Older Palæozoic Rocks, and the Fundamental Rocks, and on General Petrology, which relate more especially to the geology of the British Isles. This group is considered in detail, and constitutes the bulk of the Address.

In the second group are placed numerous papers which may roughly be classified under the following headings:—*Miscellaneous Geology, Foreign and Colonial*—a somewhat exhaustive division, comprising about a score of papers, dealing with many subjects in different parts of the world. African geology, especially, comes to the front in this group. *Miscellaneous Invertebrate Palæontology*—a score of papers may be thus classified. Most of these matters are for the consideration of specialists, relating to corals, crinoidea, bryozoa, ostracoda, cephalopoda, and to siliceous organisms. In *Palæobotany* there has only been one paper of any importance; whilst under the heading *Dynamical Problems* are a few papers dealing with the movement of material. A notice of the Inverness earthquake, and a communication on the origin of the basins of the Great Lakes of America complete this category.

The detailed consideration of the first group commences with the Newer Palæozoic Rocks. The Carboniferous system has not yielded any important stratigraphical papers of late years, but there have been some interesting communications respecting the Coal-measures. Questions as to the origin and faunal character of these are discussed by more than one writer, and very important deductions as to the delimitation of the marine and fresh-water beds have been drawn. The subject of Coal in the South-east of England was considered, *à propos* of a paper read at the Society some years ago, and the prospects of coal-getting at Dover and elsewhere in this part of England discussed. In Devonian geology, the structure and peculiarities of the South Devon Limestones form the subject of an interesting communication; and there are also important stratigraphical papers in this connection, more especially one written subsequent to the visit of a party from the International Geological Congress of London.

In the Older Palæozoic Rocks a considerable amount of work has been done, more especially amongst the Silurian and Ordovician of the North-west of England, where additional evidence has been furnished of the value of Graptolite-zones as a means of comparison with the Older Palæozoics of distant areas; and a further contribution has also been made to our knowledge of beds of this age in the Cross-Fell inlier. The papers dealing with the fossiliferous Cambrian are not numerous, but they are of great importance, including the recognition of a very low Cambrian fauna at the top of the Penrhyn quarries, and Sir J. W. Dawson's correlation of American with European Cambrians. The discovery of *Olenellus* in the "fucoid beds" of the North-west Highlands also serves to fix the Cambrian age of the Durness Limestone, to which formation the Altered Limestone of Strath in Skye, at one time regarded as of Liassic age, is now held to belong. The physical relations and the post-Cambrian metamorphism of the rocks of the North-west Highlands are also considered under this heading.

The Fundamental Rocks are roughly divided into three categories, viz.: the sedimentary series, the volcanics, and the crystalline schists. The first includes the Torridon Sandstone, the Longmynd rocks, the

unfossiliferous Cambrians of Wales, etc. The volcanic series has already formed part of the subject of an Address from the Chair. Oddly enough, the best defined pre-Cambrian, or fundamental sedimentary series, is to be found in the North-west Highlands, a district which only a few years ago was an enigma, but which we hope may now supply a clue to regions more obscure. This, of course, is the Torridon Sandstone, which has a well-defined base and a well-defined summit. Then there are certain rocks which some regard as Cambrian, others as pre-Cambrian, such as the Howth Hill and Bray Head beds, claimed as Upper Monian. Crossing St. George's Channel, we find ourselves in Anglesey, a land of pre-Cambrian mysteries. The older rocks have been described as belonging to the Monian system, an arrangement much controverted, and this controversy has extended to Shropshire. Lastly, there is the long-standing contention as to whether the unfossiliferous Cambrians of North Wales really belong to that system or should be placed on a lower horizon. The Malvernian controversy relates, in the main, to the crystalline schists.

Under the heading of General Petrology is grouped a very large series of papers, more than sixty in number, divided roughly into two primary classes, according as they relate to the British Isles or to foreign countries, the former class being alone considered in detail. The arrangement is topographical, and the rocks under this heading may be of any age from the Archæan upwards. Scotland has yielded seven papers in this group—most of them of very great interest and importance, one or two being somewhat controversial. The subject of contact-metamorphism is raised with reference to more than one Scotch locality; and from the Lake District there has been a communication on the Shap Granite and associated igneous and metamorphic rocks, which again brings this question into prominence. Some of the papers relating to Wales have already been dealt with in a previous Address, but the subjects of the Variolite and also of the Nodular Felstones of the Lleyn are noticed on the present occasion. In Devonshire the rocks formerly known as "felspathic traps" have been described as basalts and andesites; whilst the igneous origin of the Dartmoor Granite has been maintained against one of those theories which from time to time crop up with respect to this well-known *massif*. Allusion is also made to the controversy with respect to the Start rocks. There have been four papers dealing with the Lizard peninsula, in which questions as to priority of the several igneous masses and as to the origin of the banded gneisses are entertained. It cannot be doubted that considerable progress has been made of late towards a recognition of the true character of these rocks, which, for the extent of territory they occupy, are perhaps without equal in point of interest throughout the British Isles. The Address concludes with a notice of the rocks of Brittany and the Channel Isles, which have attracted the attention of more than one author.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*Council*: H. Bauerman, Esq.; W. T. Blanford,

LL.D., F.R.S.; Sir John Evans, K.C.B., D.C.L., LL.D., F.R.S.; Prof. A. H. Green, M.A., F.R.S.; J. W. Gregory, D.Sc.; Alfred Harker, Esq., M.A.; G. J. Hinde, Ph.D.; T. V. Holmes, Esq.; W. H. Hudleston, Esq., M.A., F.R.S.; J. W. Hulke, Esq., F.R.S.; Prof. J. W. Judd, F.R.S.; Prof. C. Lapworth, LL.D., F.R.S.; R. Lydekker, Esq., B.A.; Lieut.-General C. A. McMahon; J. E. Marr, Esq., M.A., F.R.S.; H. W. Monckton, Esq., F.L.S.; Clement Reid, Esq., F.L.S.; F. Rutley, Esq.; J. J. H. Teall, Esq., M.A., F.R.S.; Prof. T. Wiltshire, M.A., F.L.S.; Rev. H. H. Winwood, M.A.; Henry Woodward, LL.D., F.R.S.; H. B. Woodward, Esq.

Officers:—*President*: Henry Woodward, LL.D., F.R.S.; *Vice-Presidents*: Prof. A. H. Green, M.A., F.R.S.; G. J. Hinde, Ph.D.; Prof. J. W. Judd, F.R.S.; R. Lydekker, Esq., B.A. *Secretaries*: J. E. Marr, Esq., M.A., F.R.S.; J. J. H. Teall, Esq., M.A., F.R.S. *Foreign Secretary*: J. W. Hulke, Esq., F.R.S. *Treasurer*: Prof. T. Wiltshire, M.A., F.L.S.

III.—February 21st, 1894.—Dr. Henry Woodward, F.R.S., President, in the Chair. The President announced that the Sixth Session of the International Geological Congress will be held at Zürich from August 29th to September 2nd, 1894. The meetings are to be divided into three sections:—

1st. General Geology, etc.
2nd. Stratigraphy and Palæontology.
3rd. Mineralogy and Petrography.

Geologists having papers to present at the meetings are requested to notify the same to the Committee, and to send a short abstract of the subject with which they propose to deal. The Circular is suspended on the Notice-Board at the Apartments of the Society for the convenience of those Fellows who may desire further information.

The following communications were read:—1. "On the Relations of the Basic and Acid Rocks of the Tertiary Volcanic Series of the Inner Hebrides." By Sir Archibald Geikie, D.Sc., LL.D., F.R.S., F.G.S.

After an introductory sketch of his connection with the investigation of the Tertiary volcanic rocks of Britain, the author proceeds to describe the structure of the ground at the head of Glen Sligachan, Skye, which has recently been cited by Prof. Judd as affording inclusions of Tertiary granite in the gabbro, and as thus demonstrating that the latter is the younger rock. He first shows that the gabbro, instead of being one eruptive mass, consists of numerous thin beds and sills of different varieties of gabbro, some of which were injected into the others. These various sheets, often admirably banded, can be seen to be truncated by the line of junction with the great granophyre-tract of Glen Sligachan. A large mass of coarse agglomerate is likewise cut off along the same line. These structures are entirely opposed to the idea of the gabbro being an eruptive mass which has broken through the granophyre. They can only be accounted for, either by a fault which has brought the two rocks together, or by the acid rock having disrupted the basic. But there is ample evidence that no fault occurs at the boundary-line.

The granophyre becomes fine-grained, felsitic, and spherulitic along its margin, where it abuts against the complex mass of

basic rocks. These structures continue altogether independent of the varying distribution of the gabbros, and are seen even where the granophyre runs along the side of the agglomerate. Similar structures are of common occurrence along the margins of the granophyre-bosses and sills of the Inner Hebrides, being found, not only next the gabbro, but next the Jurassic sandstones and shales. They are familiar phenomena of contact in all parts of the world, and are sufficient of themselves to show that the granophyre of Skye must be later than the gabbro.

The author then describes three conspicuous dykes, from eight to ten feet broad, which can be seen proceeding from the main body of granophyre and cutting across the banded gabbros. One of these is traceable for more than 800 feet in a nearly straight line. The material composing these dykes is identical with that constituting the marginal portion of the granophyre-mass. It presents the most exquisite flow-structure, with abundant rows of spherulites. The author exhibited a photograph of one of the dykes ascending vertically through the gabbros. Numerous dykes and veins of the same material, not visibly connected with the main granophyre-mass, traverse the gabbros of the ridge of which Druim an Eidhne forms a part. Some of these are described in the paper, and it is shown that the flow-structure follows the irregularities of the gabbro-walls and sweeps round enclosed blocks of altered gabbro. The "inclusions" described by Prof. Judd are portions of these dykes and veins. There is not, so far as the author could discover, a single granite-block enclosed in the gabbro anywhere to be seen at this locality. He therefore claims not only that his original description of the relations of the rocks was perfectly correct, but that the evidence brought forward to contradict it by Prof. Judd furnishes the most crushing testimony in its favour.

2. "Note on the Genus *Naiadites*, as occurring in the Coal Formation of Nova Scotia." By Sir J. William Dawson, K.C.M.G., LL.D., F.R.S., F.G.S. With an Appendix by Dr. Wheelton Hind, B.S., F.R.C.S., F.G.S.

The specimens referred to in the paper occur most abundantly in calcareo-bituminous shales along the coast, at the South Joggins, and were described by the author in "Acadian Geology," in 1860. A collection of them has been submitted to Dr. Wheelton Hind. In Q.J.G.S. vol. xix. Mr. Salter referred the shells described as *Naiadites* to his new genera *Anthracoptera* and *Anthracomya*. In correspondence with Mr. Salter, the author held that the shells were probably fresh-water, and objected to the name *Anthracomya* as expressing an incorrect view of the affinity of the shells; he also stated several reasons in support of his opinions. The author continued to use the name *Naiadites*, but does not object to the division of the species into two genera, for one of which Salter's name *Anthracoptera* should be retained. Additional reasons are given for the fresh-water origin of these shells, and the author expresses his gratification that their affinities have been so ably illustrated by Dr. Hind.

Dr. Wheelton Hind believes that the "genus" *Naiadites* contains three distinct genera, for one of which the name must be retained. He proposes to retain the name for the forms called *Anthracomya*, affirming as this word does an altogether wrong affinity for the genus. (The name *Naiadites* was proposed in 1860; *Anthracomya* in 1861.)

Dr. Hind is not able to state that any of the species submitted to him by Sir J. W. Dawson are the same as British forms. The shell originally described as *Naiadites carbonaria* is, he has no doubt, an *Anthracoptera*. He gives notes on *N. arenaria*, *N. angulata*, and *N. lævis*.

CORRESPONDENCE.

PRESERVATION OF FOSSIL PLANTS.

Sir,—In answer to certain questions of a Correspondent in the December Number of this Magazine, I should like to offer the following suggestions:—

(i.) Mr. Wilmore asks why the "Carbonaceous covering" of such Coal-measure fossils as Calamites, etc., is confined to the outside of the cast. In such a plant as *Calamites* the sandstone or shale cast, which usually represents the genus in a fossil state, has frequently a layer of carbonaceous matter moulded on its surface. The sandstone or shale is simply the hardened sand or mud which fill up the hollow pith of the Calamitean stem, and the layer of coal represents the carbonized remnant of the woody and cortical tissues of the plant stem. The thickness of this coaly covering varies in different species; and it has been suggested that we may, in some cases, calculate the original thickness of the stem tissues by multiplying the thickness of the carbonaceous layer by 26. It is doubtful whether such a method should be looked to as likely to afford accurate results; but no doubt the coaly residue will vary considerably in thickness according to the diameter of the stem from which it has been formed.

In impressions of fern fronds, in which the pinnules are coated with a thin film of carbon, it is occasionally possible to trace the outlines of the original cells of the leaf.

(ii.) As to whether the carbonaceous layer on the surface of a cast represents the whole of the carbon of the plant tissues, it is difficult to say how much has escaped in a gaseous form during the gradual disorganization of the tissues; certainly the amount of carbon contained in a very thin layer must usually be regarded as the product of a much greater thickness of plant substance.

(iii.) The third question is:—"Why, in comparatively soft and little altered freestones, should the carbonaceous layer exhibit such a baked or charred appearance"? This baked or charred appearance should not merely be referred to the action of heat, but is in all probability the result of various weathering agencies and not necessarily the expression of actual charring.

Cambridge, *Feb.* 12, 1894. A. C. Seward.

THE GREAT JAPANESE EARTHQUAKE.

SIR,—In answer to some enquiries concerning the effects of the great earthquake of 1891, Professor Kotô, of Tôkyô, has just favoured me with further interesting particulars that meet some of the points mooted by the Rev. E. Hill, in this Month's Number of the MAGAZINE, and adds something to the Professor's previous paper in the Japanese Journal of Science. In this letter he remarks: "As to the questions you put on my earthquake paper, I shall attempt to answer you in a few particulars, though I may not satisfy you, owing to my superficial geological knowledge. The uplift in vertical direction, at its maximum point, is from 5½ to 6 metres. This is, however, an exceptional one, found in Modori, in the Neo Valley. This local uplift seems to me to have been caused by the pushing up of the crust between two fault-lines by lateral pressure of the neighbouring strata (see p. 340 of my paper). In all other cases the vertical displacement is insignificant; in plains it may only be seen by slight undulation of the ground. Along hill-sides it may be seen in small landslips covered by soil, and in this case the fault could not be distinguished from ordinary landslips accompanying severe shocks. A very characteristic feature of the fault in question is the horizontal displacement along the faulting plane, by which the boundaries of field becomes discontinuous. From this displacement I could measure the amount of shift of wing relative to the opposite wing. Along the junction the soil is much disturbed and raised from the surrounding field, appearing just like tracks of a mole. At the spur of the hills this could not be well seen, as the junction is covered by fallen talus. The displacement is, therefore, best studied in cultivated fields. I have traced the Neo fault for 112 km. by the marks left in the fields by slight elevations, and by displacement of field boundaries, and the regularity and constancy of these marks. Sometimes I have traced it in wooded hills where I often lost sight of the marks, but by the help of the compass I caught the track again beyond the hills on the other side. It was a very troublesome task to keep my route right in this way.

"You ask me whether the faulting plane is *vertical* or *oblique*? I am sorry I cannot tell you which it is. As may be understood from the foregoing statement the vertical displacement, as a general rule, amounts to very little. The best opportunity for study in this direction may be that of Midori (photograph, Pl. xxxiv.), but, unfortunately, the faulting took place in alluvial ground, consequently solid strata did not come into view at the surface. As the raised mound in the fields is very narrow and sharply marked, I surmise that the faulting plane is vertical, or nearly so; if, on the contrary, the faulting plane makes large angles, with normal upon the surface, the head of shifting plane should not be so clearly marked as in the Mino-Owari district, but the proximity of fault must be much disturbed, which is not the case with ours.

"Whether the hard rocks, as well as the drift-gravel and sand, are affected by the fault is the next question you put to me, which I answer in the affirmative. As the line of fault goes through field

and hills as well as mountains alike with great regularity and sharpness, I think I am justified in saying that the hard rocks are also affected by the fault. If diluvial and alluvial deposits were only affected by it, the line must be of only short distance, and may perhaps not be a straight line, but I found the line of fault crossed intervening hills and appeared again on the opposite side, keeping thereby the same direction on either side. The faulting in one case took place in a rocky crust, and must be deep-seated. Unfortunately the fault did not cross the hard, eroded valley bottom where the effect of *friction* by shifting might perhaps be observed.

"The next question is whether the shock was of sudden or prolonged nature. As there was no sign of change in topography before the last convulsion, the shock must be a sudden one, otherwise houses standing upon the fault-line must have inclined toward one or other side before the shocks, which was not the case, at any rate I have heard of no such signs when going through earthquake-districts when I had opportunity to converse with the unhappy people. I think the faulting, which produced the last catastrophe, was what the miners call *heave*, or *blatt* of German geologists, *i.e.* the fault crossing the strike of strata complex. If the solid large mass of crust had suddenly shifted, as I think was the case in the earthquake of Japan 1891, a great amount of friction must have occurred along the plane of fault, and thereby, mechanically, heat may have been developed which may have melted the rock or produced slicken-side on the cheeks of bounding rocks. I regret much that I made no observations in this direction. Till now I have not heard of any new appearances of hot springs in faulted district. In every textbook on geology it is stated during mountain-making process faults are produced by which rock-masses slide along the dislodged plane, thereby partially melting the neighbouring rocks by the development of mechanical heat by friction, and convert a rock into another form and producing regional metamorphism. In the last sudden faulting no such changes were observed by me. Such phenomena might occur in the deeper parts of the earth-crust, but near the earth-surface, so far as I know, nothing resembling such phenomena was observed or recorded by any person."

Allow me to observe in reply to Mr. Hill's courteous letter that I do not take the great fault at all as a measure of the forces to be dealt with, but merely as an indication of their *nature*, and not as evidence of their *degree*, which can only be judged of by the results in each particular case of disturbance.

SHOREHAM, KENT.
10th March, 1894.

JOSEPH PRESTWICH.

WILLIAM PENGELLY, F.R.S., F.G.S.—With deep regret we record the death of this well-known geologist, who has done so much during the past forty years in the exploration of Brixham Cave, and Kent's Cavern, Torquay; in the establishment of the Devonshire Association for the Advancement of Science, and the Torquay Natural History Society. He died at Torquay on 17th March, in his 83rd year. We hope to give an Obituary Notice of Mr. Pengelly next month.